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EXAMINING FISCAL ENVIRONMENTS FOR INCREASED LOCALISATION OF SOLAR PRODUCTS

A study on solar refrigerators and walk-in cold rooms in India and Kenya

MARCH 2023

EFFICIENCY FOR ACCESS COALITION

ACKNOWLEDGEMENTS

Efficiency for Access is a global coalition working to promote high-performing appliances that contribute to clean energy access for the world's poorest people; its members lead programs and initiatives spanning three continents, 44 countries and 22 technologies. This report seeks to provide Efficiency for Access stakeholders with an understanding of the potential for localisation of off-grid solar refrigeration equipment, such as solar refrigerators / fridges and solar walk-in cold rooms. It aims to generate insights and provide information on the feasibility of localising off-grid solar refrigeration supply chains. It also provides fiscal and non-fiscal measures required to help India and Kenya shift towards localisation.

This study was conceived and administered by Richa Goyal, Senior Insight Manager, Energy Saving Trust. This report was prepared by pManifold (authors: Rahul Bagdia, Yamini Keche, Ankit Agrawal, Apurva Parakh and Akshay Gattu) in consortium with Africa Energy Services Group (AESG) (Albert Bhutare, Collin Gumbu, Isaac Kiunga and Emmanual Thomas). The following individuals made valuable contributions to help improve the quality of this report and provided feedback throughout the development: Leo Blyth, Chris Beland and Charles Miller from Energy Saving Trust.

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About Efficiency for Access

Efficiency for Access is a global coalition working to promote high performing appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development. Efficiency for Access consists of 20 Donor Roundtable Members, 19 Programme Partners, and more than 30 Investor Network members. Current Efficiency for Access Coalition members have programmes and initiatives spanning 62 countries and 34 key technologies. The Efficiency for Access Coalition is coordinated jointly by CLASP, an international appliance energy efficiency and market development specialist not for-profit organisation, and UK's Energy Saving Trust, which specialises in energy efficiency product verification, data and insight, advice and research.

The Low Energy Inclusive Appliances programme is Efficiency for Access' flagship initiative.

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ACRONYMS & ABBREVIATIONS

AC	Alternating Current
ALMM	Approved List of Models and Manufacturers
BCD	Basic Customs Duty
BOM	Bill of Materials
CAPEX	Capital Expenditure
CBU	Completely Built Units
CKD	Completely Knocked Down
COMESA	Common Market for Eastern and Southern Africa
COVID	Coronavirus Disease
DC	Direct Current
DCR	Domestic Content Requirement
EAC	East African Community
EMI	Equated Monthly Instalment
EPRA	Energy and Petroleum Regulatory Authority
EPZ	Economic Processing Zones
EV	Electric Vehicles
FDI	Foreign Direct Investment
FOB	Free On-Board
FPO	Farmer Producer Organisation
GDP	Gross Domestic Product
GMCC	Guangdong Meizhi Compressor Co
GST	Goods and Service Tax
GW	Gigawatt
HS	Harmonised System
ICLEI	International Council for Local Environmental Initiatives
IEC	International Electrotechnical Commission
IGST	Integrated Goods and Service Tax
IIT	Indian Institute of Technology
INR	Indian Rupee
IP	Intellectual Property
PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
LCD	Liquid Crystal Display
LEIA	Low Energy Inclusive Appliances
MEPS	Minimum Energy Performance Standards
MIDH	Mission for Integrated Development of Horticulture
MNRE	Ministry of New and Renewable Energy
MOQ	Minimum Order Quantity

MRP	Market Retail Price
MSIPS	Modified Special Incentive Package Scheme
MW	Mega-Watt
NGO	Non-governmental organisation
NITI	National Institution of Transforming India
NSDC	National Skill Development Council
OEM	Original equipment manufacturer
PAYGO	Pay-as-you-go
PCM	Phase Change Material
PLI	Production-Linked Incentive
PSSC	Power Sector Skill Council
PUF	Polyurethane Foam
PV	Photovoltaic
SCE	Solar Cooling Engineering
SDD	Solar Direct Drive
SDG	Sustainable development goals
SEZ	Special Economic Zones
SGD	Safeguard Duty
SHS	Solar Home System
SKD	Semi-Knockdown
TES	Thermal Energy Storage
USA	United States of America
USD	US Dollars
VAT	Value-Added Tax
WTO	World Trade Organisation

Over the years, the off-grid solar industry has prioritised cost reduction and profitability, resulting in the increasing globalisation of supply chains. For many manufacturers, this has also resulted in an increased reliance on low-cost countries like China. The COVID-19 pandemic brought with it delays in the worldwide flow of raw materials and components, impacting businesses financially. Post-pandemic, companies are now reconsidering the financial benefits of relying on a global supply network versus a more local supply network.

The localisation of supply chains can, in certain cases, raise consumer prices and production expenses due to the limited demand for locally manufactured products. However, it can also have extensive advantages, such as more job opportunities and tax revenue, crucial factors to consider as we recover from the effects of the recent global supply chain crisis following the pandemic.

Localisation could provide suppliers with greater control over manufacturing standards and subsequently improve product quality and customer satisfaction. Additionally, localisation can help enterprises minimise their carbon footprint as goods and components travel much shorter distances.

Localisation is unlikely to meet all of industry's needs but shifting the balance away from globalisation, may well provide security, environmental benefits, better job prospects and increased skills and resilience in times of uncertainty.

Today, many countries are keen to promote localisation and are putting in place incentives to stimulate private-sector investment in local manufacturing and assembly. Off-grid solar refrigeration equipment, such as solar refrigerators / fridges and solar walk-in cold rooms, are currently only marginally viable when manufactured or assembled locally in India and Kenya, the two countries considered in this study.

With about 0.8 million off-grid solar items sold in 2020, India is one of the largest markets for off-grid solar appliances in the world. Off-grid solar refrigerators have a market potential of EUR 19.6 billion (USD 20.6 billion)[1] but this off-grid sub-sector is still in its infancy due to high upfront capital costs and low awareness of the technology among end-users. India still relies on imports, especially imported solar photovoltaic (PV) cells and modules, primarily from China. The Government of India (GoI) launched several policy initiatives to stimulate domestic manufacturing, including the National Solar Mission in 2010 which required bidders to use solar PV modules manufactured domestically. In 2012 GoI launched the Modified Special Incentive Package Scheme (MSIPS) which provided a 20-25% subsidy for investments in capital expenditure for the setting up of electronic manufacturing facilities. To further help the sector, in 2014 the GoI implemented policies such as the Domestic Content Requirement (DCR) mandating that solar powered projects source their solar cells and modules domestically and introduced the Safeguard Duty (SGD) of 25% in 2018 to dampen the influx of cheap imports.

Furthermore, the GoI approved the Production-Linked Incentive (PLI) scheme for investment in high-efficiency solar PV modules in April 2021. The Ministry of Finance issued an order to impose 40% and 25% Basic Custom Duty (BCD) on the import of solar modules and solar cells, respectively, beginning April 1, 2022. Despite the existence of these economic incentives, the recent pandemic has had a negative impact on the off-grid solar refrigeration industry, as it has on other sectors. Domestic firms have been feeling the pressure as demand has dropped and exports have become impossible. Because of these issues, countries are considering reducing the reliance on international imports or looking for alternative suppliers.

Similarly, in Sub-Saharan Africa, despite the use of various policy instruments such as faster processing of business applications, infrastructure development, and fiscal incentives to promote assembly / manufacturing of OGS products, the contribution of manufacturing to national economies remains low. Local assembly and manufacturing companies face regulatory, economic and financial challenges alongside uncertainties in market conditions and skills limitations. Inadequate information, and the fact that importing is cheaper than assembly /manufacturing are added issues. Feedback from interviews conducted with stakeholders as part of this research, shows that the most prominent barrier for domestic companies' operations and scalability is their restricted access to credit from financial institutions, such as local banks, impact investors and donors.

In Kenya, in spite of OGS products officially being exempt from import duties and Value Added Tax (VAT), in practice both are still imposed on several sub-components of PV systems. This has been an ongoing issue for companies importing products with a lack of clarity on how individual components, and system parts are taxed. The result has been higher product charges, lower margins for the companies and higher product prices for consumers, thereby reducing demand and the overall size of the market. Moreover, the VAT percentage rate is continually changed, with new terms set nearly every financial year, which also leads to unpredictability and uncertainty, over and above the absolute cost implications. This set of challenges have significantly hindered companies from shifting towards local assembly / manufacturing.

1 Decentralised Solar Refrigeration: Opportunities in the Livelihood Appliance Market in India, GOGLA, 2020, https://www.gogla.org/sites/default/files/draft_ppt_sharing_of_report_findings_on_19th_jan_v3.pdf

EXECUTIVE SUMMARY

The potential off-grid solar appliance market is fairly large and has a range of applications in several market segments. In Chapter 1, the existing state of the off-grid solar market in India and Kenya is examined in order to determine the use case for off-grid solar with the greater potential for localisation. Using a top-level scan of the off-grid solar market in both countries, two application cases—solar walk-in cold rooms for farm-gate (in close proximity to farms) and solar commercial refrigerators for micro-enterprises—were identified and are detailed in Chapter 2.

According to market research findings, solar commercial refrigerator sales in Kenya and India are still in their infancy. The solar walk-in cold room market in India is far more established than in Kenya because of substantial government support. India is a large market for solar with Phase Change Material (PCM) technology for solar walk-in cold rooms, and it is expected to have a greater market share shortly. While solar commercial refrigerators in India rely on storage services by way of electrochemical batteries, the future of solar applications with batteries will be determined by EV adoption in the country. On the other hand, Kenya mostly uses electrochemical batteries for both refrigerators and walk-in cold rooms.

The market assessment finds that India sources the off-grid solar refrigeration components locally to some extent, whereas Kenya is predominantly dependent on the importation of completely built units. The majority of the components required for solar walk-in cold rooms and solar commercial refrigerators are sourced locally in India. Kenya needs to accelerate its efforts towards localising major components. India is already moving in this direction and has some companies beginning to establish manufacturing for DC compressors.

An analysis of existing market conditions has revealed that India has better potential for off-grid solar localisation than Kenya. India and Kenya need to primarily focus on demand creation (local as well as export) to gradually transition towards localisation. India must solve challenges such as lack of demand and high local taxes to facilitate scale-up and a move towards localisation.

To stimulate industrial localisation, Kenya must focus on developing favorable fiscal conditions, such as exemption from local taxes on the appliance and its components.

An economic assessment that showcased the realities of increasing localisation of specific use cases was undertaken, as detailed in Chapter 3. The economic analysis included appliance and plant level economic assessments for solar walk-in cold rooms. This research provides a deep dive on economic assessment, but in reality there could be other levers for local manufacturing.

The economic analysis demonstrated that solar walk-in cold rooms localisation is viable if there is adequate demand. With increasing demand and increasing localisation, the material cost is also reduced making the production more economical. The material cost also reduces with increasing localisation since the dependency on imports is reduced and the associated taxes are also eliminated. Moreover, for appliance level assessment comparing the different localisation scenarios for solar walk-in cold rooms using PCM technology, it was observed that the Market Retail Price (MRP) of a localised unit in India is ~18% less than in Kenya.

The plant-level economic assessment for solar walk-in cold rooms found that increased localisation reduces breakeven volume demand. At the plant-level, profits can be achieved at lower volume sales with increased localisation. Nevertheless, profits are offset by an increase in the capital cost required to set up manufacturing facilities and procure materials. Increased capital cost investment is therefore a significant issue in discouraging OEMs from shifting towards higher localisation. Fiscal incentives like the provision of capital funds could thus play a significant role in enabling local manufacturing / assembly.

Based on the economic assessment, key fiscal and non-fiscal recommendations for both government stakeholders and private companies are made in Chapter 4. Market dynamics and the investments in local companies will determine whether there is a compelling economic case for investing in the off-grid solar sector on the private side. This includes whether there is enough unmet demand to make a large facility competitive, as well as the viability of exporting excess production. Some of the key recommendations are as follows:

Non-Fiscal Measures

- 01 Create demand through public procurement backed by minimum threshold quality parameters
- 02 Develop export-oriented market
- 03 Establish quality standards and test methods
- 04 Provide upskilling and capacity building local assembly and local manufacturing
- 05 Explore partnership opportunities for south-south & triangular cooperation and leverage 'China-plus-one' strategy

Fiscal Measures

- 01 Reduce or exempt local taxes on appliance and its components
- 02 Increase import duties on import of completely built units
- 03 Introduce safeguarding tax to protect local industry (for Kenya)
- 04 Provide capital subsidy and foreign investments to set-up local manufacturing / assembley facilities
- 05 Provide funds for R&D activities and incubating technology start-ups

Governments have a number of possible levers to boost local assembly and manufacturing. These include incentives for local assembly / manufacturing, reservations in national tenders, subsidies and tax exemptions, investment in special economic zones, and skill-development initiatives. The availability of these levers varies by country and national governments' inclination towards the off-grid solar industry determines their readiness to use these levers. Eventually, it will have to be a collaborative effort by government, industry, donor agencies and development banks to support the localisation of the off-grid solar market in India and Kenya.

Chapter 1: Introduction

The purpose of this study is to better understand the localisation potential of off-grid solar refrigeration equipment covering both solar refrigerators and solar walk-in cold rooms (given high impact of cooling technologies such as combating heat stress, reducing food losses, increasing end-user income) and to identify areas of intervention to make supply chains more resilient to pandemic-like situations. This report examines the potential for localisation through the following lenses:

1. Evaluation of potential off-grid solar refrigeration appliances and technologies across various end-user segments that can be localised
2. Assessment of the current and future markets for the identified off-grid solar refrigeration appliances; existing supply chains; challenges and areas for improvement for localisation
3. Possibilities for localising the production of the components for increased localisation
4. Economic evaluation of localising (local assembly / local manufacturing) the identified off-grid solar refrigeration appliances
5. Recommendations for manufacturers and policymakers to increase localisation

The results of this study are intended to provide an important component of the evidence base off-grid appliance stakeholders need to support increased adoption of affordable off-grid solar refrigeration appliances via an economically efficient appliance procurement strategy.

Global landscape

Manufacturing sector growth is critical to a country's economic progress. Countries today are eager to promote local manufacturing and are putting incentives in place to attract private sector investment in local manufacturing and assembly across wide range of industries, including the off-grid solar industry. The main advantages of localisation for any country include supply chain stability and local job creation. If the COVID-19 pandemic has shown anything, it is that global supply chains are vulnerable. Sourcing materials from a specific region or a single supplier makes a company's / industry's supply chain extremely vulnerable to disruption. Hence, localising supply chains helps manufacturers become more resilient to global supply chain disruptions in pandemic-like situations. Localisation also has the potential to provide widespread employment for a sizable portion of the young population, allowing them to escape poverty. The recent pandemic has highlighted the importance of local actors in crisis response.

Figure 1 Key benefits of localisation

SUPPLY CHAIN STABILITY

Local manufacturing helps in stabilising the supply chain in which materials and other resources are sourced from companies operating nearby. This shortens the lead time on materials, as manufacturers do not need to wait for materials to ship overseas. Moreover, there is also an increase in revenue for manufacturers since there is reduction in the staggering logistics cost due to imports. Localisation also helps manufacturers become more resilient to supply chain disruptions in pandemic like situations.

LOCAL JOB CREATION

Supporting local manufacturing companies directly supports not only the local labour markets but the local economy too because the cost of manufacture is not being paid to an overseas company. It's not just the direct manufacturing jobs that it will be helping to create either, but the many ancillary ones too like those making the components used in the manufacture and even delivery drivers who will need to deliver products to end-users.

Therefore, it is crucial to review localisation efforts in varied contexts, as well as the opportunities and problems they bring. It will be crucial to keep track of and review the policies and techniques that various nations employ as they move toward localisation. The following sections summarise localisation efforts in the renewable energy sector section particularly for solar PV module in a non-representative sample of countries. Some of these measures serve as valuable lessons for drafting localisation strategies for off-grid solar refrigeration equipment sector in India and Kenya.

China

A long-term strategic plan for solar manufacturing by the Chinese central and provincial governments has existed since the 2000s, and it has helped China become a global leader in the supply chain for solar PV modules. The construction of massive, integrated giga-factories from 2015 to 2020 was made possible by state assistance, which helped solar manufacturers survive economic downturns. In terms of research and development, equipment manufacturing, and the production of supplementary materials, Chinese enterprises currently have a dominant position. Chinese solar manufacturers have achieved scale and lower prices by localising the supply chain.

The upstream and downstream value chains are both emphasised in the country's policy instruments. While China has used a number of strategies to become a global leader, some of the most important fiscal measures that have assisted China in becoming a pioneer in the production of PV modules include significant investments in research and development, refund policies, the provision of low-rate loans, tax credits, and subsidies for installations (which is now being phased-out over-time).

China

PHASE 1: Rural Electrification
Mid 1990s–2003

- Launch of two programs namely the Brightness Program in 1996 and the Township Electrification Program in 2002 to support rural electrification by making use of renewable energy

PHASE 2: Export — Oriented Growth
2004–2008

- Shift of solar PV policy to an export-oriented growth stage driven jointly by the explosive growth of global demand for solar PV as well as by a number of domestic factors like a strong incentive to facilitate the growth of local PV industries
- Influx of a substantial amount of capital from foreign stock markets enabled the Chinese PV industry to expand its production capacity at an unprecedented rate
- Global financing paved the way for the Chinese PV industry to tap into a huge pool of foreign capital and the leading PV firms in China were able to greatly expand their production scale

PHASE 3: Growing Industry & Market Support
2009–2011

- Impact of global financial crisis in 2008 severely and adversely impacting China's PV industry
- Policy makers stimulated domestic demand as a means to offset the effects of the financial crisis
- Local government issued various refund policies which were supported by their tax revenues to promote new plant investment in PV industry
- The production of PV cell, wafer and polysilicon in China increased 8.3 times, 10 times and 17.89 times respectively
- The government launched two national solar subsidy programs: the Rooftop Subsidy Program (50%) and the Golden Sun Program (70%)

PHASE 4: Government — Supported Investment
2012 onwards

- The massive, government — supported investment between 2009 and 2011 resulted in even greater overcapacity of solar panel manufacturing by 2012
- Ensuing decline of prices caused some US and EU solar PV manufacturers go bankrupt
- US and the EU triggered the 'anti-dumping' and 'anti-subsidy' investigations which, in turn, have had an adverse impact on China's solar PV industry
- Government promulgated intensively a series of policies to provide stronger support for distributed solar PV (DPV) power, adjusted the capacity-based subsidies, and introduced a resource-based Feed-in-Tariff (FIT) scheme

PHASE 5: Government — Supported Investment
2015 onwards

- The government was forced to reduce the level of subsidy and curb rising costs. However, the phased subsidy reductions encouraged a boom in solar development as companies sought to bring their facilities into operation before reductions took effect
- The National Energy Administration launched its 'Forerunner' initative. This encouraged new solar facilities to use advanced products with higher solar cell efficiencies to demonstrate technological advances and promote cost reductions

China's solar power sector started to grow not only in manufacturing, but also in domestic installations due to strong government backing and a favourable policy environment. China is currently dominating all steps of the global photovoltaic solar panel production process.

KEY FISCAL POLICY INSTRUMENTS SUPPORTING SOLAR PV MANUFACTURING IN CHINA

1 INVESTMENT IN R&D

- Innovation fund ($2.9 million) for small technology-based firms to promote manufacturing
- Established national key laboratories at several leading firms

2 REFUND POLICIES

- Refund or exemption of land fee and tax (corporate income tax, VAT (50%) and interest on loans) by local government
- Refund of electricity consumption fees
- Refund of import and value-added tax for R&D equipment

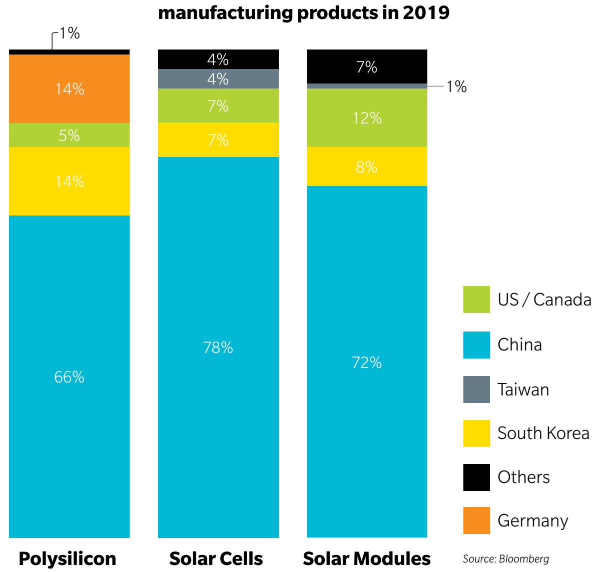
3 LOW-RATE LOANS & TAX CREDITS

- Cheaper loans were provided at interest rates of 0–0.5% for setting up manufacturing facilities for a longer time frame for PV manufacturers
- Post 2008 global financial crisis, the China Development Bank (CBD) opened a line of credit worth US$30bn for solar cell and module manufacturers

4 SUBSIDY FOR INSTALLATIONS

- National PV Subsidy to promote Building Integrated PV (BIPV)
- Second national PV subsidy package — the Golden Sun Program — designed to subsidise 6,00MW of PV demonstration projects

Country Market share of different solar PV manufacturing products in 2019



CONCLUSION

A strong support to domestic solar manufacturing sector through fiscal policy measures coupled with fortuitous global developments for the industry have enabled Chinese firms to dominate the global market. Moreover, the scale of government support for solar PV manufacturing sector has also made China's supply chain resilient to pandemic-like shocks.

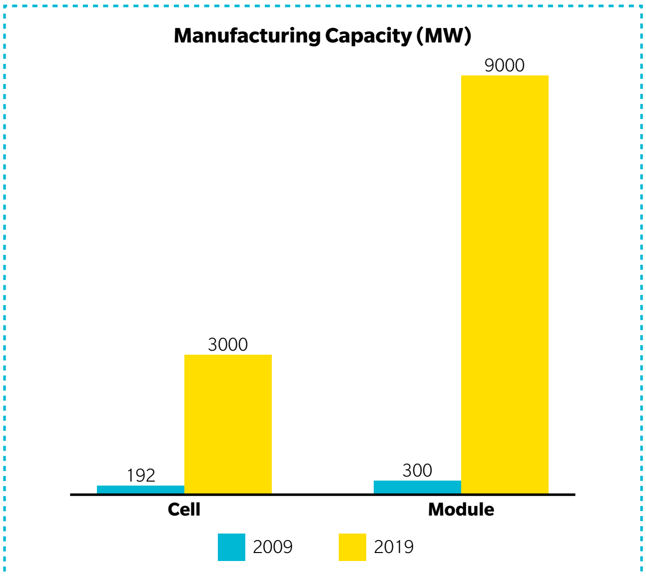
India

With the introduction of the National Solar Mission in 2010 and the first-ever solar tenders of 150 MW and 350 MW, India began its efforts to promote the production of solar PV modules. India's production capacity has increased steadily over the years. From a meagre 192 MW cell and 300 MW module manufacturing capability, Indian producers are now able to create 3 GW of cells and 9 GW of PV modules. However, since India is still largely dependent on imports, much work still needs to be done.

In 2021, there was significant policy backing for local solar manufacturing. The government-imposed import taxes created a pre-approved list of modules to be used in projects and unveiled a manufacturing-related subsidy programme in 2021. A Basic Customs Duty (BCD) of 25% on imported solar cells and 40% on imported solar modules was announced by the Ministry of New and Renewable Energy (MNRE) in March 2021, effective in April 2022. (MNRE 2021b). In 2021, the MNRE published the initial Approved List of Models and Manufacturers (ALMM) for solar modules. Nearly all projects being established in India are required by government directives to use only the modules on the ALMM list. Only indigenous companies are included in the list as of December 2021, effectively prohibiting foreign companies from selling in India.

Additionally, the government promised funding for integrated solar manufacturing worth EUR 570 million (USD 600 million at the time of writing) under the Production Linked Incentive (PLI) scheme.[2] The proposal got bids for a combined 16 GW of polysilicon, 29 GW of wafer, 52 GW of cells and modules, and 3 GW of integrated thin film manufacturing capacity. Three companies were chosen from a shortlist and have plans to build 12 GW of fully integrated solar manufacturing capacity. A further EUR 2.4 billion (USD 2.6 billion) has been allotted by the government to increase the number of PLI grantees.

India's manufacturing capacity has grown at a good pace, in the last 10 years. From a mere 192 MW cell and 300 MW module manufacturing capacity, today Indian producers are capable of manufacturing 3 GW of cells and 9 GW of PV modules.



KEY POLICY INSTRUMENTS SUPPORTING SOLAR PV MANUFACTURING IN INDIA

2010
National Solar Mission
- Mission required bidders to use solar photovoltaic (PV) modules manufactured domestically in the first-ever solar tenders of 150 megawatt and 350 megawatt

2012
Modified Special Incentive Package Scheme
- Provided 20–25% subsidy for investments in capital expenditure for setting up of electronic manufacturing facility
- Reimbursement of Countervailing Duty (CVD) / Excise Duty for capital equipment for the units outside Special Economic Zone (SEZ)

2014
Domestic Content Requirement (DCR)
- Mandated the solar power projects under Government Producers Scheme (CPSU Scheme), KUSUM Scheme, New Roof-top Scheme to source their requirement of solar cells & modules from domestic sources, in a WTO compliant manner

2018
Safeguard Duty (SGD)
- SGD (25%) was levied with a view to promote domestic manufacturing and curb imports on imports of solar cells and modules (including imports from China, Thailand and Vietnam)

2021
Production Linked Incentive (PLI)
- Government approved the PLI scheme for the solar PV manufacturing sector, with INR 4500 crore (US$603 million) allocated by the ministry of New and Renewable Energy (MNRE) for investment in high-efficiency solar PV modules

2022
Increase in BCD
- Ministry of Finance has provided long-term policy certainty by issuing an order to impose 40% and 25% Basic Custom Duty (BCD) from April 1, 2022, on the import of solar modules and solar cells, respectively

CONCLUSION

Government policy support in fiscal areas through schemes such as PLI, Approved List of Models and Manufacturers (ALMM) and increase in BCD, have generated huge interest in solar PV manufacturing from several companies. Although India is far behind from China in manufacturing capacity, supportive government plans and conducive conditions could make India a solar manufacturing hub in years to come

South Korea

The South Korean government has concentrated its efforts on promoting the domestic sector through R&D investment. In order to establish a unified PV research centre for evaluating PV module component (crystalline silicon) technology, the government also intends to invest EUR 22 million (USD 23 million). Around EUR 3.4 billion (USD 3.6 billion) investment was made in the solar sector in 2020, with most of the investment going toward solar PV projects.[3]

Taiwan

Taiwan has introduced domestic content requirements and fiscal incentives to promote local industry in order to accelerate its solar deployment programme. Taiwanese regulations restrict

2 https://www.meity.gov.in/esdm/pli
3 https://www.ceew.in/cef/solutions-factory/publications/making-india-a-leader-in-solar-manufacturing

the purchase of Chinese modules and provide a 6% tariff bonus for power purchased from energy generators that use certified, high-efficiency domestic modules. Furthermore, Taiwanese cell manufacturers have restructured their businesses in order to expand into module manufacturing.

Southeast Asia

Large Chinese manufacturers are incentivised by tax breaks to establish cell and module production operations in Southeast Asian nations like Malaysia, Thailand, and Vietnam. For instance, Malaysia is planning a 3 GW cell and module plant with administrative support in the form of a government incentive programme that offers five-year tax rebates to businesses relocating to Malaysia. With the planned factory, the government anticipates creating more than 3,000 new jobs. Similar investments are made throughout Thailand and Vietnam.

United States of America

In order to support local manufacturing, the US imposed anti-dumping duty on imports of solar PV from China and Taiwan in 2012. More recently, in 2018, the US imposed a safeguard duty on imports of solar cells and modules, at first set at 30% and later lowered to 18% by 2022. In 2021, in order to further support localisation, American legislators suggested a production-based tax credit for solar PV components made in the country.[4]

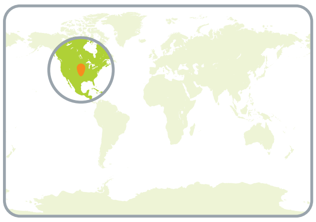
The US has been a pioneer in terms of distributing R&D funds for various energy technologies, However, its solar industry is mostly dependent on imports, with imports accounting for more than 90% of solar deployment in 2021. One major reason is the failure to ensure market deployment of technologies that have received investment.

The United States also provided bailouts and grants to its solar players, particularly in the aftermath of the 2008 recession. Despite interventions, the incentives failed to secure a strong manufacturing base in the United States.

Summary of support provided for localisation

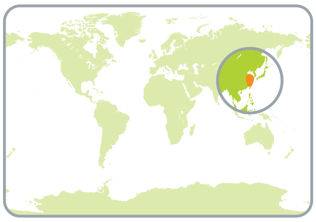
Overall, consistent access to credit and subsidy support aid manufacturers in overcoming financial challenges and serve as a crucial fiscal policy measure to boost localisation. Additionally, offering tax incentives to foreign investors that wish to establish manufacturing facilities aids in the growth of local manufacturing capacity.

Examining fiscal environment for increased localisation of Off-Grid Solar Refridgerators



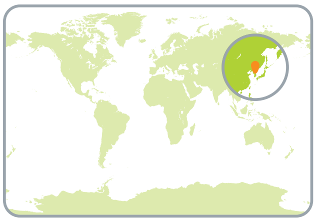
USA

- The US Government poured **R&D funding** into early-stage solar technologies
- However, its solar industry is almost entirely import-reliant, with imports contributing to over 90% of solar deployment in 2021
- The failure to ensure market deployment of technologies which received investment are key reasons for continued import-reliance
- Proposed a production-based tax credit for domestically manufactured solar PV component



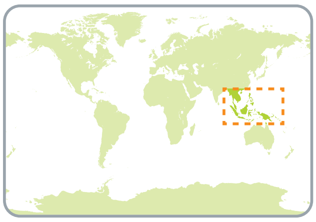
Taiwan

- Introduced **domestic content requirements** and fiscal support to promote local industry
- **Restricted the purchase of Chinese modules** and **provide a 6% bonus on tariffs** for power procured from energy generators that use certified, high-efficiency domestic modules



South Korea

- Focused efforts on advancing the domestic industry through **R&D funding**
- Plans to invest USD 23 milion (INR 173 crore) to set up a common PV research centre for testing crystalline silicon technologies



Southeast Asia

- Chinese manufacturers have set up cell and module production units in Southeast Asian countries such as Malaysia, Thailand, and Vietnam to avoid import duties from US and Europe
- Local governments **provide tax incentives** to new entrants setting up large-scale manufacturing facilities
- Malaysia provides **five-year tax exemptions** to companies relocating to Malaysia. Similar investments exist across Vietnam and Thailand

4 https: / / www.ceew.in / cef / solutions-factory / publications / making-india-a-leader-in-solar-manufacturing

Table 1: Summary of support provided by countries for localisation

SUPPORT PROVIDED FOR LOCALISATION	CHINA	INDIA	SOUTH KOREA	TAIWAN	SOUTHEAST ASIA	USA
Subsidies and incentives to set-up manufacturing facilities	✓	✓			✓	
Dedicated access to loan financing	✓					
Other financial support from the government (equity, grants, loan guarantees)	✓	✓		✓		✓
Creation of manufacturing hubs, SEZs and regional government support	✓				✓	
Investment in R&D and Technology development	✓		✓			✓
Demand creation and incentive framework for high-efficiency products	✓	✓	✓	✓		
Import restrictions to support localisation	✓	✓	✓	✓		✓

Key lessons for India and Kenya for increased localisation of off-grid solar:

1. Effective policy support in the form of subsidies, tax incentives, grants, loans, import restrictions, and the creation of export demand
2. Securing supply chains by manufacturing bill of materials (BoM) components and manufacturing equipment locally
3. Fostering technological leadership and operational excellence with an emphasis on R&D

Chapter 2: Market assessment of off-grid solar refrigeration appliances

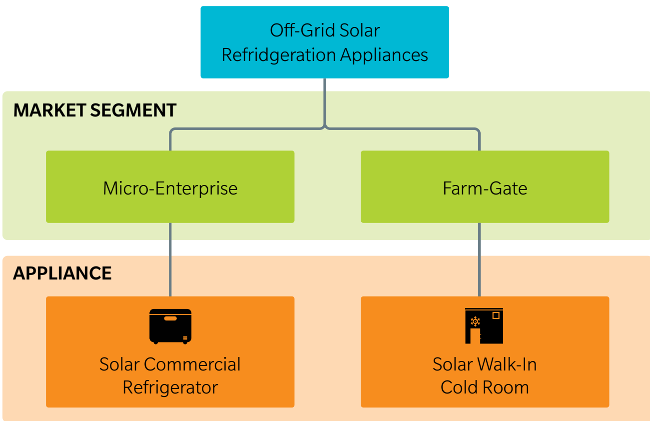
Off-grid solar appliances are used in a variety of markets for different purposes and at varying temperatures. A solar commercial refrigerator, for example, can be used in small grocery stores to store beverages, milk, and so on, and solar cold storages are used in farm-gate to store fruits and vegetables. As a result, before delving into the localisation potential of off-grid solar refrigeration appliances, it is necessary to assess the potential off-grid solar refrigeration appliance use cases across different market segments in India and Kenya.

Methodology

- A mix of primary and secondary research was conducted to provide a top-level assessment of the potential use cases for further analysis of localisation potential across four market segments (healthcare, household, micro-enterprise, and farm-gate)
- The analysis included 11 different parameters to shortlist the top two use cases with high potential for localisation for each of India and Kenya

Based on the analysis of Solar Commercial Refrigerator (micro-enterprise) and solar walk-in cold rooms (farm-gate) were shortlisted for further analysis for both India and Kenya as shown in Figure 2.

Figure 2 Shortlisted off-grid solar refrigeration use cases



There is a high potential for localisation of off-grid solar refrigeration appliances in micro-enterprise and farm-gate market segments for both India and Kenya as shown in Table 2 and Table 3. Farm-gate cold storage facilities have a high impact on livelihoods, particularly in the rural regions and are, therefore, backed by significant government support in India. Additionally, in the Farm-gate market segment there is already a certain degree of localisation for solar walk-in cold rooms which makes a better case for further evaluating the potential for transitioning to complete localisation.

The Solar Commercial Refrigerator, on the other hand, is primarily import dependent in both Kenya and India but has a high potential for localisation with an enabling ecosystem. Given the low market penetration of domestic off-grid solar refrigerators and their non-affordability, the household market sector has little scope for localisation. This is because there is a dearth of consumer financing for off-grid consumers and there is not enough debt or working capital to invest in R&D and produce affordable appliances. In the Healthcare market segment, procurement mostly happens through government agencies. Therefore, financial indicators and incentives will have a negligible effect on industry-level localisation.

Table 2: Use case selection analysis | India

SN	PARAMETERS	HEALTHCARE	HOUSEHOLD	MICRO-ENTERPRISE (RETAIL)	FARM-GATE
	PREVALENT OFF-GRID SOLAR REFRIGERATION APPLIANCE	SOLAR VACCINE REFRIGERATOR	SOLAR REFRIGERATOR (SINGLE DOOR, WITHOUT FREEZER)	SOLAR COMMERCIAL REFRIGERATOR	SOLAR WALK-IN COLD ROOM
1	**Total Annual Sales** (including conventional) **	More than 100K units	More than 100K units	More than 100K units	Less than 10K units
2	**Off-Grid Annual Sales** *	Less than 5% of total annual sales	Less than 5% of total annual sales	Between 5% to 15% of total annual sales	>15% of total annual sales
3	**Tentative End-user price** (off-grid appliance + associated system) **	150L capacity; $1K (EUR 991) to $10K (EUR 9,918)	150L capacity; Less than $1K (EUR 991)	150L -200L capacity; < $1K (EUR 991)	5 MT capacity; > $10K (EUR 9,918)
4	**Affordability** ***	Purchases mostly done by Govt. and NGOs whose purchasing power is high	Rural off grid community have low incomes impacting ability to buy	Most purchases done by business enterprises with varied purchasing power	High capital investment but is highly supported by Govt. subsidy (~50-75%)
5	**Prominence of Solar Technology** ***	Govt. push through tenders	Limited consumer awareness, poor brand recognition of off-grid solar refrigeration products	Govt. financing support to micro-enterprises using solar powered livelihood appliance	Explicit Govt. focus on solar cold storage facilities through schemes like MIDH

SN	PARAMETERS	HEALTHCARE	HOUSEHOLD	MICRO-ENTERPRISE (RETAIL)	FARM-GATE
	PREVALENT OFF-GRID SOLAR REFRIGERATION APPLIANCE	**SOLAR VACCINE REFRIGERATOR**	**SOLAR REFRIGERATOR** (SINGLE DOOR, WITHOUT FREEZER)	**SOLAR COMMERCIAL REFRIGERATOR**	**SOLAR WALK-IN COLD ROOM**
6	**Long-term Scalability Potential *****	Dependence on Govt.	Market dominated by organised players; Off-Grid Solar Refrigeration market not developed, also demand is low	Nascent market; lower CAPEX through govt. support translating into higher adoption	Nascent market; Higher need, Strong Govt. support through subsidy driving market growth
7	**No. of Off-Grid Manufacturers / Assemblers ****	More than 5 players	3-5 players	3-5 players	More than 5 players
8	**Impact on SDGs ****	3-6 SDGs	3-6 SDGs	More than 6 SDGs	More than 6 SDGs
9	**Rural India Economy Improvement Potential *****	Indirect economic benefits of longer life expectancy	Consumptive appliance	Productive appliance	Productive appliance
10	**Government willingness to drive increased localisation** (measured in terms of Duty; high Duty >> high import discouragement) ******	7.5% BCD	7.5% BCD	7.5% BCD	10% BCD; 10% Social welfare surcharge
11	**Potential for localisation according to Industry ***	Medium	Low	High	High
	TOTAL SCORE	**22**	**18**	**27**	**29**

*primary research; **secondary research; ***mix of primary and secondary research

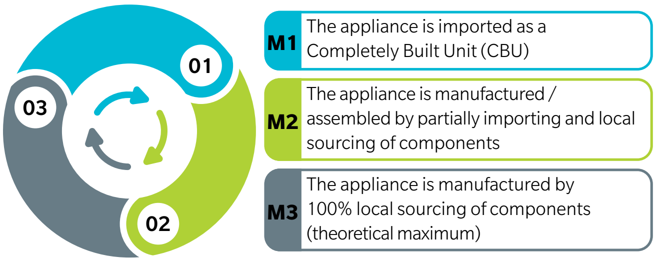
Table 3: Use case selection analysis | Kenya

SN	PARAMETERS	HEALTHCARE	HOUSEHOLD	MICRO-ENTERPRISE (RETAIL)	FARM-GATE
	PREVALENT OFF-GRID SOLAR REFRIGERATION APPLIANCE	**SOLAR VACCINE REFRIGERATOR**	**SOLAR REFRIGERATOR** (SINGLE DOOR, WITHOUT FREEZER)	**SOLAR COMMERCIAL REFRIGERATOR**	**SOLAR WALK-IN COLD ROOM**
1	**Total Annual Sales** (including conventional) ******	Less than 50K units	More than 100K units	Between 50k to 100K units	Less than 50K units
2	**Off-Grid Annual Sales ***	200 to 800 units	200 to 800 units	More than 800 units	Less than 200 units
3	**Tentative End-user price** (off-grid appliance + associated system) ******	50 L capacity; between $600 (EUR 595) to $1200 (EUR 1,190)	165 L capacity; between $600 (EUR 595) to $1200 (EUR 1,190)	225 L capacity; between $1200 (EUR 1,190) to $10,000 (EUR 9,918)	5MT; more than $10,000 (EUR 9,918)
4	**Affordability *****	Purchases mostly done by government and NGO whose purchasing power is high	Rural off grid community have low incomes impacting their ability to buy	Most purchases done by business enterprises with varied purchasing power	High capital investment and low disposable income of customers
5	**Expected % Solar market capture in near future**	Market capture potential between 10% to 35%	Market capture potential <15%	Market capture potential >35%	Market capture potential <15%
6	**Long-term Scalability Potential *****	Increasing involvement of NGOs and Development Partners	Impacted by affordability issues in rural communities	Nascent market, Lower capital costs will induce high demand	Nascent market; Strong Govt. support through subsidy can drive market growth
7	**No. of Off-Grid Manufacturers / Assemblers ****	Less than 5 players	5-8 players	5-8 players	Less than 5 players
8	**Impact on SDGs ****	Impact on 3-6 SDGs	Impact on 3-6 SDGs	Impact on more than 6 SDGs	Impact on more than 6 SDGs
9	**Rural Kenya Economy Improvement Potential *****	Indirect economic benefits of longer life expectancy	Consumptive appliance	Productive appliance	Productive appliance
10	**Government willingness to drive increased localisation** (measured in terms of Duty; high Duty >> high import discouragement) ******	10% customs duty deductions on components, 0% duty on raw materials	10% customs duty deductions on components, 0% duty on raw materials	10% customs duty deductions on components, 0% duty on raw materials	0% duty on raw materials
11	**Potential for localisation according to Industry**	Low	Low	High	High
	TOTAL SCORE	**21**	**19**	**28**	**19**

*primary research; **secondary research; ***mix of primary and secondary research

The shortlisted use case market was further evaluated to understand the existing market landscape and potential opportunities for localisation. The inputs from the detailed market assessment will help to evaluate economic assessment across different manufacturing options as shown in Figure 3.

Figure 3: Manufacturing Options



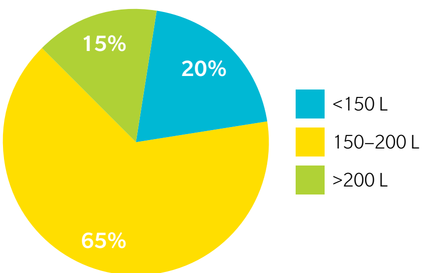
Market Assessment of solar commercial refrigerator and solar walk-in cold room in India

Market Assessment of Solar Commercial Refrigerator used in Micro-enterprises

The Solar Commercial Refrigerator market is at an infant stage in India with only a few players in the market. 200L is the most commonly sold solar commercial refrigerator with a price range of USD 900-1,300 (including system cost). Some industry experts anticipate that the market shall shift towards higher capacity refrigerators (250-300L) in the coming years due to higher efficiency, and reducing prices of panels and Li-ion batteries, and AC/DC interoperability, while some experts suggest the shift towards smaller capacities is due to greater affordability and willingness to pay among more number of users.

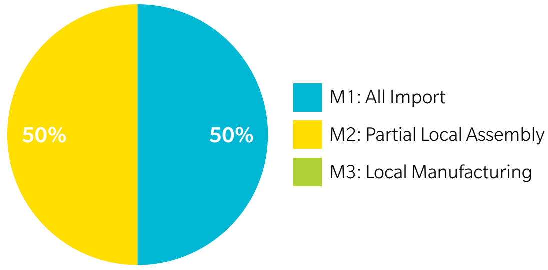
Currently, 50% of solar commercial refrigerators are imported as Completely Built Units (CBUs-M1) while the remaining 50% are manufactured by partial local sourcing and partial imports of the components. DC compressor and power electronics components are generally imported, whereas energy equipment such as solar battery, PV module, charge controller, mechanical components, refrigerator cabinet, balance of system, etc. are locally sourced.

Figure 4: Market share by capacity



Source: pManifold Analysis

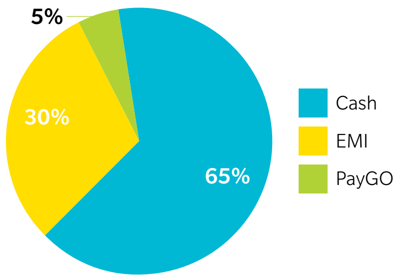
Figure 5: Market share by manufacturing options



Source: pManifold Analysis

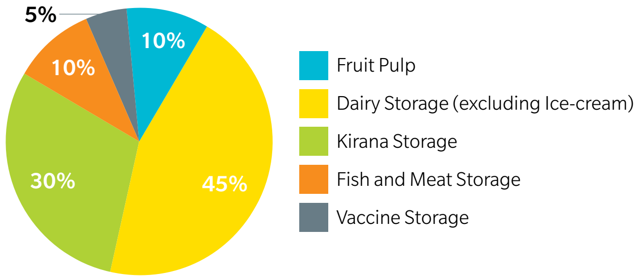
M1 is currently the preferred option due to high quality, better finishing of the product and lower cost over M2 and M3. Today, for a manufacturer, 65% of sales are B2B (i.e. cash), 35% is B2C (which is primarily EMI based sales) and the remaining 5% are exports, primarily to Africa where PayGo model is offered to end-users by local player. The Solar Commercial Refrigerator is mostly used in Kirana stores (small retail grocery stores) and Dairy Storage with an estimated 75% combined market share.

Figure 6: Market Share by business model



Source: pManifold Analysis

Figure 7: Market share by use-case



Source: pManifold Analysis

The estimated sales of solar commercial refrigerators were ~6,000 units as of 2021 while annual sales are expected to become ~12X by 2024. Most of the demand is expected from Kirana stores in rural areas due to the growing requirements for cold beverages. Devidayal Solar, Rockwell, and Phocos India are some of the prominent players in the market.

Electrochemical battery (lead-acid tubular batteries) is the most used battery technology. Phase Change Material (PCM) Technology share is about 20% but has some performance related challenges like leakage. Future technology advancement is expected to address such challenges and thereby gain higher market shares in future. Many players have also started to use a combination of PCM and electrochemical batteries in cold room applications. To help make refrigeration equipment more affordable, end of life EV batteries that are discharged at as high depth of discharge as 80% or more can be used with stationary refrigeration applications.

Figure 8: Sales trend for Solar Commercial Refrigerators in India

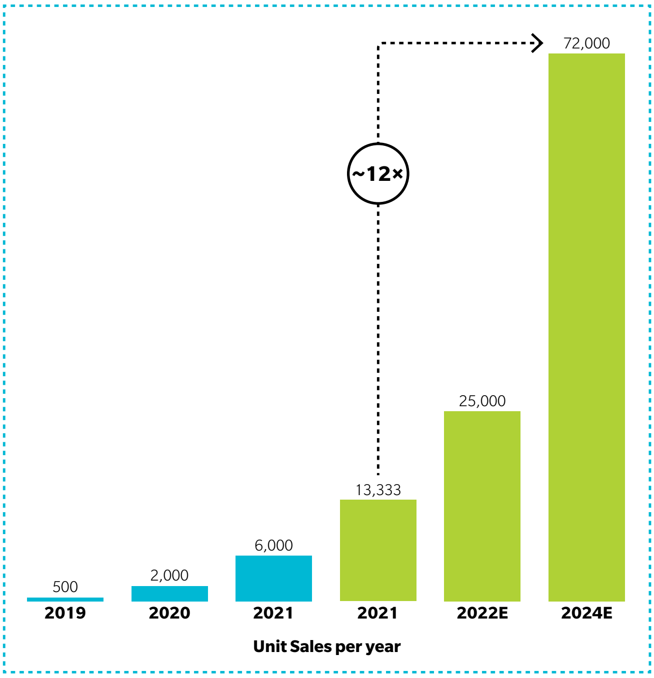
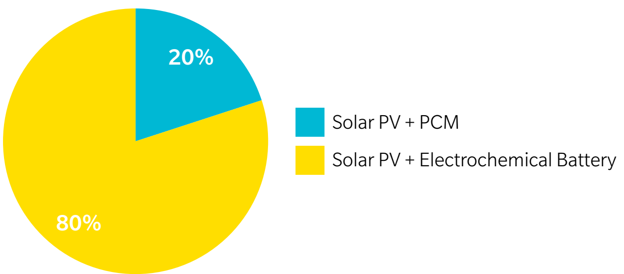


Figure 9: Market share by technology



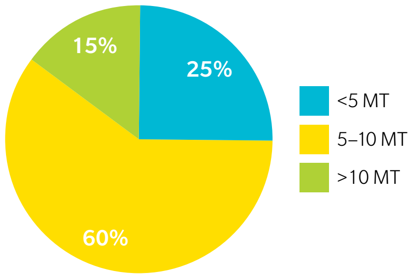
Source: pManifold Analysis

Market assessment of solar walk-in cold rooms used in farm-gate

The solar walk-in cold room market is a growing market in India. As estimated by our research, around 20-30% of produce is wasted post-harvest due to the non-availability of nearby cold storage facilities. Running cold storage facilities requires regular electricity but grid electricity in rural areas is often unreliable. Solar-powered cold storage systems provide a solution, but these have found limited adoption among farmers as these systems require an upfront investment of typically around EUR 15,869-22,812 (USD 16,000-23,000) per unit for a 5 MT solar-powered cold storage. 5 tonnes is also the most sold capacity of solar walk-in cold rooms.

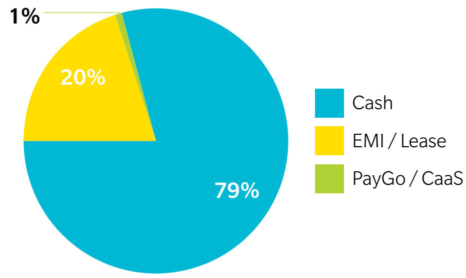
Currently, almost all solar walk-in cold room manufacturers are doing partial local sourcing (M2 Manufacturing Type). By value, 30-35% of the components are being imported, while the remaining components are locally sourced and manufactured. DC compressor and power electronics components are generally imported, whereas other components such as solar battery, module, charge controller, mechanical components, refrigerator cabinet, balance of system, etc. are locally sourced.

Figure 10: Market share by capacity



Source: pManifold Analysis

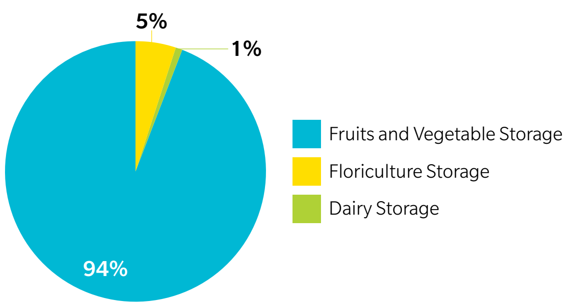
Figure 11: Market share by Business Model



Source: pManifold Analysis

The solar walk-in cold rooms are mostly purchased upfront by Farmer Produce Organistions (FPO) with financial support from the government through subsidies. They are also provided on lease to the consumers since, at times for individuals or groups of small holder farmers, the upfront purchase is difficult due to high costs. The lease period for solar walk-in cold room is generally 2-5 years. Solar walk-in cold rooms are used mostly for F&V Storage with estimated ~95% market share followed by floriculture products (flower and flower bud).

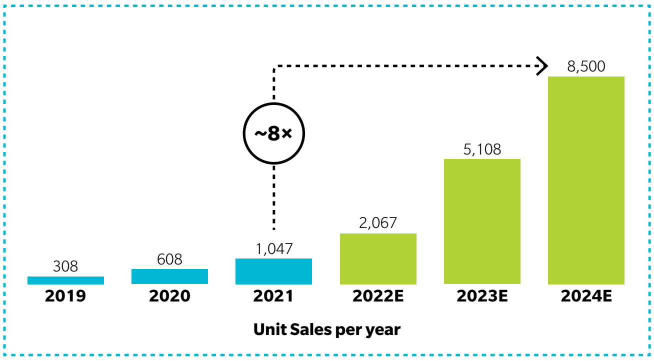
Figure 12: Market share by Use-case



Source: pManifold Analysis

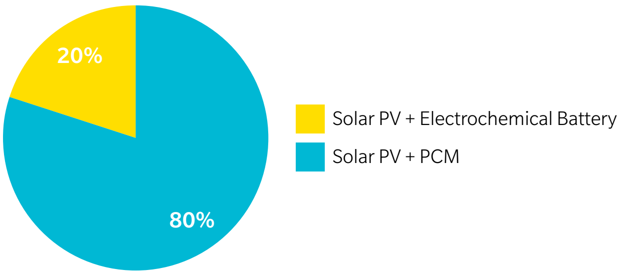
The estimated total annual sales of solar walk-in cold rooms were ~1000 units in 2021. The annual sales are expected to increase eightfold by 2024 due to growing cold chain infrastructure market which has significant support from government in order to reduce post-harvest losses and increase farmers income. Ecozen, Inficold, Icemake India and Cool Crop are some of the prominent players in the market.

Figure 13: Sales trend for solar walk-in cold rooms in India



Currently, Solar PV with phase change materials (Solar Direct Drive) is the most used technology for solar walk-in cold rooms. However, OEMs will have to include Solar PV + Electrochemical Battery in their portfolio to cater to lower temperature requirements. PCM technology is capable in maintaining a positive range of temperature (till ~4 degrees Celsius) but not helpful in lowering the temperature to freezing temperatures. Off-grid biomass powered Walk-in Cold Rooms are also available in the country.

Figure 14: Market share by technology



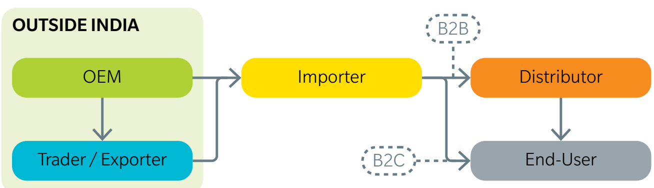
Source: pManifold Analysis

Supply Chain of OSGRs across different manufacturing options in India

M1: All Import (Completely Built Unit (CBU)

Under manufacturing option M1, the off-grid solar refrigerator is imported as a completely built unit from the exporter (outside India) and generally from China. The imported product lands at the country ports and reaches the importer. The importer usually sells to a distributor (B2B) which is then passed on to the end-user. At times, the importer also sells the product directly to the end-user.

Figure 15: M1 Supply Chain



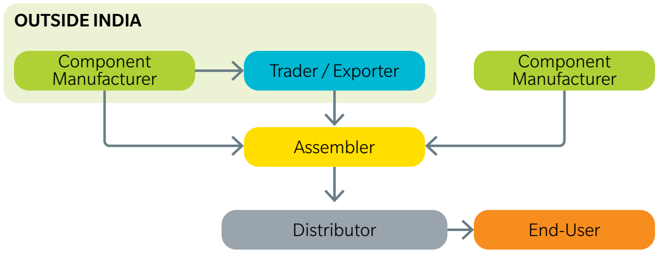
Source: pManifold Analysis

M2: Partial Local Assembly (Completely / Semi Knocked Down

Under manufacturing option M2, the off-grid solar refrigeration appliance is assembled locally by partially importing and partially local sourcing of components. The major refrigeration system component, the DC compressor, is often imported from Thailand, Taiwan, and Brazil. However, recently (GMCC), a Midea Group company with a global market share of compressors of approximately 34%, is establishing its first compressor manufacturing facility outside of China in India. Thus, making compressors available for off-grid solar refrigeration applications.

Refrigerant is usually imported from Europe but also at times locally sourced while power electronics are imported from US, Singapore and Ireland. The off-grid solar refrigeration appliances employing PCM technology usually use locally manufactured Thermal Energy Storage (TES) panels.

Figure 16: M2 Supply Chain



Source: pManifold Analysis

Table 4: Sourcing status of the off-grid solar refrigeration appliance components in India

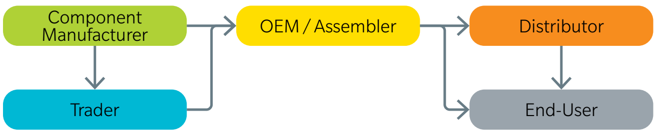
SN	BILL OF MATERIALS	IMPORTED / LOCALLY MANUFACTURED OR SOURCED OR ASSEMBLED	COUNTRY OF IMPORT
1	**Solar Panel***	Locally manufactured	-
2	**Charge Controller**	Locally manufactured	-
3	**Lead- Acid Solar Tubular Battery**	Locally manufactured	-
4	**Solar Mounting Panel**	Locally manufactured	-
5	**Power Electronics**	Imported	USA, Singapore, Ireland
6	**Electrical Components**	Locally manufactured	-
7	**Mechanical Components**	Locally manufactured	-
8	**Compressor**	Imported	Brazil (AC), Taiwan (DC), Thailand (DC), Brazil (DC)
9	**Refrigerator Cabinet**	Locally manufactured	-
10	**PUF Panel****	Locally manufactured	-
11	**Refrigerant**	Locally manufactured & imported	Europe
12	**Balance of System**	Locally manufactured	-
13	**Thermal Energy Storage (TES) panels**	Locally manufactured	-

Note: Locally sourced components may or may not be locally manufactured / assembled
*Solar cells are imported from China for manufacturing modules. Sometimes, directly imported from China
**Raw materials to manufacture PUF panels are imported from USA, Germany, China

M3: Local Manufacturing

Under manufacturing option M3, which is a desirable state for most off-grid solar refrigeration manufacturers, the off-grid solar refrigerator is assembled / manufactured by locally sourcing all the components. Some players like Exalta India, claim to be providing 100% locally sourced off-grid solar refrigeration including compressors and also exporting to gulf countries.

Figure 17: M3 Supply Chain



Source: pManifold Analysis

Key findings from the India Market

1. Reasons to shift to localisation

- **MOQ Constraint:** Import orders generally have a minimum order quantity (MOQ) condition which forms a constraint for small and medium sized manufacturers. Local supply chain allows to cater to small order quantities
- **Increased Lead times:** Local sourcing has shorter lead times as compared to foreign imports
- **Offering Customisation:** Catering to customisable solutions is feasible with local sourcing and manufacturing

2. Potential components to be localised

- **DC Compressors:** India can move away from the technology of rotary motors and instead opt for indigenous technologies for DC compressors. OEMs should collaborate with incubators in institutions like IITs, where R&D for such technologies are on-going

3. Volumes (of appliance or of components) that will drive localisation

- **Controller card:** As per interviews, locally manufactured solar controller card prices can be matched with those being imported if the order quantity is more than 25,000 units for a single OEM
- **DC Compressor:** Annual manufacturing of AC Compressors runs into millions in India. Thus, for compressors, volume is not a constraint, rather a clear roadmap needs to be adopted to create manufacturing capabilities for DC compressors alongside AC compressors

4. Impact of COVID-19

- **Increase in BOM Cost:** Maximum impact of COVID-19 was observed on freight charges which increased by more than 550%. As a result, bill of materials (BOM) cost of solar commercial refrigerator increased by ~15%. For solar walk-in cold rooms, BOM cost increased by ~10%
- **On Manufacturing Type:** M2 manufacturing experienced more impact by the lockdown's regulations. M1 manufacturing share increased during during COVID times

5. Challenges in shifting to localisation

- **Solar commercial refrigerators:** Some of the most critical challenges include lack of consumer awareness and demand, lack of end-user financing, high local taxes (GST), and cost disparity between local manufactured and imported CBUs
- **Solar walk-in cold room:** Some of the most critical challenges include lack of performance standards, lack of OEM and end-user financing, lack of policy support, and high local taxes (GST)
- **Lower Cost and Better Quality:** CBU solar commercial refrigerators, which have better quality and finishing, costs ~25% lesser than partially locally sourced counterparts

6. Challenges with Standardisation and Certification

- **Lack of testing labs:** There aren't enough testing labs in India capable of testing off-grid refrigerators. Indian OEMs need to ship their products to Europe for testing, which is time consuming and expensive
- **Lack of Universal IEC Standard:** There is no universally approved IEC standard. Each African country has different requirements so multiple IEC / CVG tests are required for exports, making it difficult for Indian manufacturers to export to African countries
- **Lack of Star Labelling:** Star Labelling, which is currently missing, is required to increase customer awareness regarding benefits of DC appliances

7. Levers enabling shift to localisation

- **Taxation:** Currently, the effective GST on solar appliances in India is ~14%. This should be reduced to 5% to promote local manufacturing. Tax holidays on GST should be introduced for OEMs for 4-5 years
- **Subsidy:** Backend norm on subsidies for appliances like solar cold storage should be removed. Subsidy should be increased from 35% to 50-70%, at least in the initial years
- **Financing:** Currently financing is either not available for off-grid solar appliances or available at a high interest rate of 17%. End-user financing should be made available at no interest rates or a low interest rate of 5%

8. Required Government Support

- **Support in GeM Portal:** Solar Refrigerator category should be included in the Government e-Market Place (GeM) portal. This proposal is currently at a roadblock because of counteracting inclusion criteria and regulations.
- **Development of FPOs:** Currently, there are ~5000 Farmer Production Organisations (FPOs) in India, however, less than

5% are using solar walk-in cold rooms. Development of FPOs should be initiated along with increasing deployments of off-grid solar cooling appliances

- **Support for initial volumes:** Similar government programmes like Saubhagya[5] and KUSUM[6] should be initiated for solar appliances to enable demand aggregation. Government should aim at creating impact in 0.2-0.3 million homes in India
- **Development of marginalised areas:** Government can target sales in NITI Aayog aspirational districts (Adivasi area) who have a high need for the appliances, but is not matched by an ability to pay

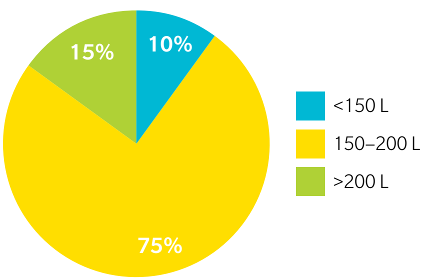
Market assessment of solar commercial refrigerators and solar walk-in cold rooms in Kenya

Market assessment of solar commercial refrigerators used in micro-enterprises

In Kenya, the market for solar commercial refrigerators is still in its early stages of development and has enormous potential. Due in part to the longer guarantee period of 5 years as opposed to just 2 years for 100L, 170L capacity is the most popular capacity in Kenya. Currently, solar commercial refrigerators are imported as fully assembled M1 units because they are not manufactured or assembled locally. The power source equipment, such as solar panels and batteries, is often imported separately.

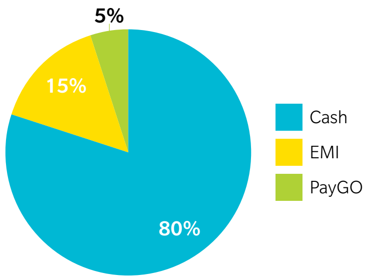
The industry plans to switch to M2 if the enabling environment is favourable and includes a stable fiscal regulatory framework. M2's scope will remain limited to domestic assembly of imported parts. The foundation for some kind of local assembly is the pervasive maintenance and repair work for AC refrigerators. It will therefore take time to move to 100 percent localisation because much groundwork must first be done to transform the off-grid solar refrigeration business from an emerging stage to one that is competitive.

Figure 18: Market share by capacity



Source: pManifold Analysis

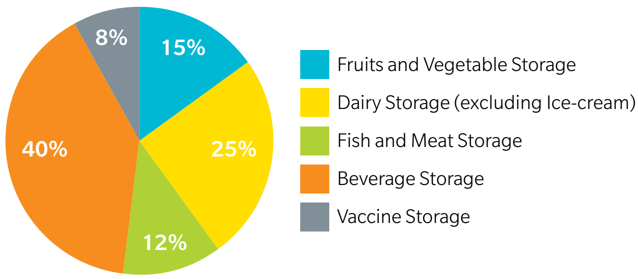
Figure 19: Market share by Business Model



Source: pManifold Analysis

There are different business models operating, but cash is the dominant one. Off-grid refrigerator purchase transactions are considered too big for PAYGO despite its popularity with SHS in Kenya. Solar Commercial Refrigerators are mostly used for storing beverages and dairy products.

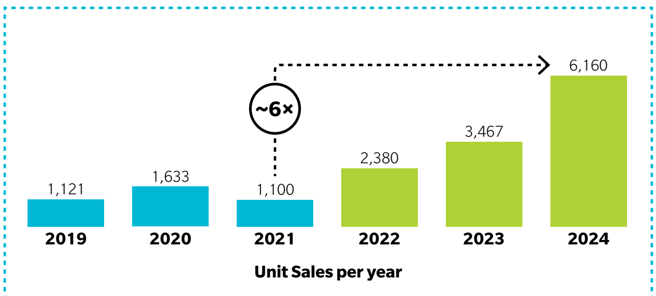
Figure 20: Market share by use-case



Source: pManifold Analysis

According to stakeholder interviews, annual sales of solar commercial refrigerators were ~1,100 units in 2021, a 33% decrease from 2020. COVID-19 had a greater negative impact on demand and sales in 2021, owing to falling household income. This resulted in layoffs and a reduction in operations. Low penetration is also due to a lack of affordability and access to financing. The upfront cost of a refrigerator is estimated to be 2.5 times greater than the annual disposable income of the poorest 50% of the off-grid population. Sales are expected to increase as the country recovers from the effects of COVID-19.

Figure 21: Sales trend of solar commercial refrigerator in Kenya

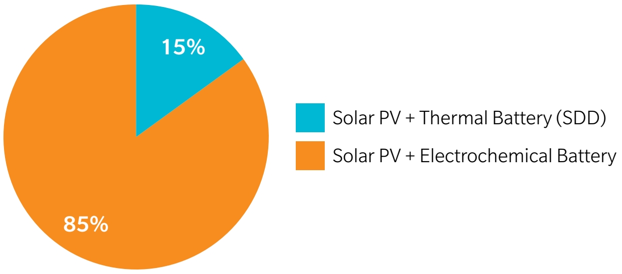


5 REC, Government of India, 'Saubhagya', https://recindia.nic.in/saubhagya (accessed 5 December 2022)

6 Ministry of New and Renewable Energy, Government of India, 'Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyaan (PM-KUSUM)', https://pmkusum.mnre.gov.in/landing-about.html (accessed 5 December 2022)

In terms of technology, vaccine refrigerators are more usually equipped with Solar Direct Drive (SDD) technology than commercial solar refrigerators, which typically combine solar power with electrochemical batteries. However, manufacturers are introducing SDD into new markets. As the industry wants more efficient and cost-effective cooling, SDD with PCM is predicted to dominate the next generation of off-grid refrigeration technologies.

Figure 22: Market share by technology

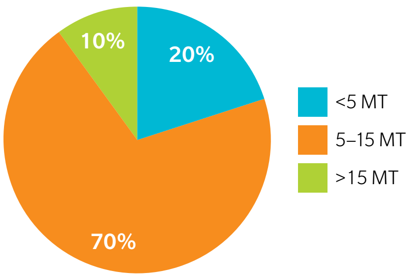


Source: pManifold Analysis

Market assessment of solar walk-in cold rooms used in farm-gate

The solar walk-in cold room market (as well as the conventional (grid powered) walk-in cold room market) is largely underdeveloped in Kenya. However, driven by the need to reduce post-harvest losses, fresh food spoilage and wastage, solar walk-in cold room are gaining interest at the farm-gate level. Currently, the solar walk-in cold room capacity ranging from 5-15 MT is the most sold capacity.

Figure 23: Market share by capacity



Source: pManifold Analysis

For solar walk-in cold rooms, M1 and M3 manufacturing types are non-existent. Local sourcing is limited on materials and components for the containerised cold room structure as they are designed to meet a client's specific needs. The manufacturing type is 100% M2 with the imported materials largely the cooling units and the power equipment taking up to 50% of product market value.

For a manufacturer, 85% of sales are B2B which employs Cooling-as-a-Service (CaaS) model where end-users pay on a per-use or a per-crate basis and do not own the asset themselves. Manufacturers are also pursuing involvement of NGOs to bear the initial cost of the equipment.

Figure 24: Market share by Business Models

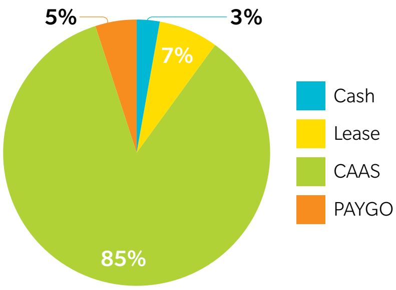
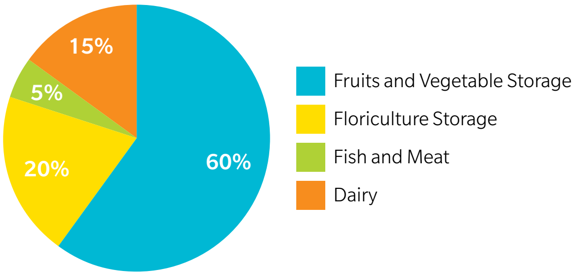


Figure 25: Market share by use-cases



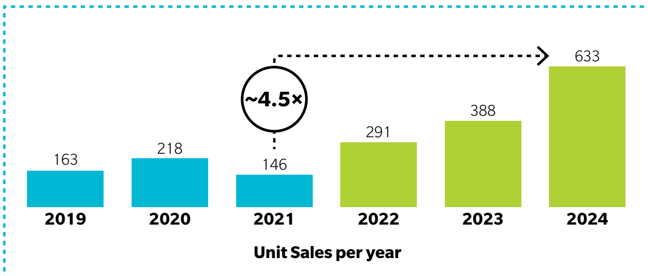
Source: pManifold Analysis

As per stakeholder interviews, annual sales of solar walk-in cold rooms were 146 units in 2021, a 49% decrease from 2020. COVID-19 impact on sales was felt most in 2021 due to supply chain disruptions which affected the availability and the price of raw materials. However, the sales are expected to grow (as shown in Figure 26) as the country recovers from COVID-19 impacts and as successful pilots are scaled.

East Africa Community (8 partner states - 290 million population size) is a potential export market to encourage further localisation and more so moving from M2 to M3.

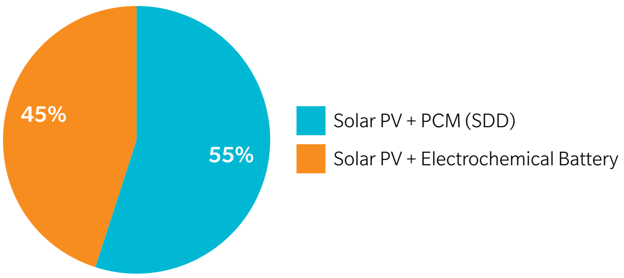
Several farm-gate enterprises (e.g., D-Grid and Ecolife) are engaged in piloting local assembly projects to test the models and understanding of the market. It will be useful to learn about their findings to catalyse localisation.

Figure 26: Sales trend of walk-in cold room in Kenya



For solar walk-in cold rooms, currently, both solar with PCM and solar with electrochemical battery technologies are being used. However, PCM is gaining more interest since it is cheaper compared to batteries.

Figure 27: Market share by technology



Source: pManifold Analysis

Supply chain of OSGRs across different manufacturing options in Kenya

M1: All Import (Completely Built Unit (CBU)

The supply chain for M1 option is similar to India (see page 23) where most of the off-grid solar refrigerators are imported as CBUs from China.

M2: Partial Local Assembly (Completely / Semi Knocked Down)

The supply chain under manufacturing option M2 is also similar to India where the off-grid solar refrigerator is assembled locally by partially importing and partially local sourcing of components. The major refrigeration system component, the DC compressor, is often imported from Germany, China and Asia. Refrigerant is usually imported from Germany, China and Asia but also at times locally. Batteries are usually imported from India, China and Korea.

Table 5: Sourcing status of off-grid solar refrigeration components in Kenya

SN	BILL OF MATERIALS	IMPORTED / LOCALLY MANUFACTURED OR SOURCED OR ASSEMBLED	COUNTRY OF IMPORT
1	**Solar Panel**	Import and locally assembled	China, Asia, USA
2	**Charge Controller**	Import	China, Asia
3	**Battery**	Import and locally assembled	China, Asia (India), Korea
4	**Solar Mounting**	Locally assembled	Kenya
5	**Power Electronics**	Import	Germany, China, Asia
6	**Electrical Components**	Import	Germany, China, Asia
7	**Mechanical Components**	Import	Germany, China, Asia
8	**Compressor**	Import	Germany, China, Asia
9	**Refrigerator Cabinet**	Import and locally assembled	Kenya, Germany, China, Asia
10	**PUF**	Import	Germany, China, Asia
11	**Refrigerant**	Import	Germany, China, Asia
12	**Balance of System**	Import and locally assembled	Kenya, Germany, China, Asia

M3: Local Manufacturing

M3 option is currently non-existent in Kenya.

Key findings from the Market Assessment

1. Potential components to be localised

- **Solar Commercial Refrigerator:** Some of the key components that could be locally manufactured and sourced include solar PV module, battery and refrigerant
- **Solar walk-in cold room:** Energy equipment like solar panel, battery, charge controllers can be purchased from local distributors (who in turn import them mainly from China) while materials and components for the containerised cold room structure units can be sourced locally. However, high-tech components such as DC pumps, heat exchangers and cooling units are unlikely to be manufactured locally

2. Volumes (of appliance or of components) that will drive localisation

- Currently the market for Solar commercial refrigerators and WICR market is uncompetitive (mostly dependent on imports) and at a nascent stage. most companies are on pilot runs and are still figuring out business models and demand levels
- **Solar Commercial Refrigerator:** As per stakeholder consultations, annual demand quantity of ~5,000 units of solar commercial refrigerators at an industry level can drive feasibility of local manufacturing and assembly
- **Solar walk-in cold room:** It is difficult to comment on the WICR volumes required to drive localisation. A detailed economic assessment needs to be conducted to evaluate this

3. Impact of COVID-19

- **Reduced Sales:** Due to falling household incomes and changed preference of end-users, sales witnessed a decline during the COVID-19 period
- **Supply Chain Disruptions:** Factors like unavailability of raw materials contributed to disruptions of the supply chain of appliances, thereby delaying imports
- **Lay-offs:** Declining demand and profits also saw staff lay-offs from stakeholder companies

4. Challenges in shifting to localisation

- **Solar Commercial Refrigerators:** Some of the most critical challenges include:
  - Lack of working capital
  - Competitive price and better quality of imported appliances
  - Inconsistent and unpredictable tax laws
  - Lack of end-user awareness
  - Lack of capable partners with required market and technology skills
  - Lack of quality standards for locally assembled products

- **Solar walk-in cold room:** Some of the most critical challenges include:
  - Lack of access to Intellectual Property (IP) Rights to enable local engineers to design best in class components
  - Lack of state of the art, large scale incubation programs to facilitate commercialisation and business expansion after proof of concept stage
  - Lack of concessionary financing (ideally with less than 10% interest rate) to serve as working capital for emerging entrepreneurs engaged in local assembly venture
  - Lack of end-user awareness on capabilities and benefits of WICR to instil confidence on the product and prompt purchase decision
  - Tedious and bureaucratic process to get Value Added Tax (VAT) exemptions for off-grid components

5. Challenges in shifting to localisation

- **Solar Commercial Refrigerator and Solar walk-in cold room:** Minimum Energy Performance Standards (MEPS) are available but overseen by Energy and Petroleum Regulatory Authority (EPRA). In this regard, Kenya adopted the IEC 62552 2015 that describes the methods for the determination of performance requirements.
- **Lack of R&D and testing facilities:** Government should set-up R&D facilities to support research activities with Universities and other like-minded institutions to solicit data that would inform viable and innovative off-grid solar refrigeration technologies to test the innovative and local technologies.

6. Levers enabling shift to localisation

- **Supply Chain:** Local sourcing and manufacturing strengthens the resiliency of supply chain.
- **Government Incentives:** Government has extended fiscal incentives to promote local manufacturing and assembly in Kenya which could be leveraged.
- **Import taxation:** For solar commercial refrigerators, application of safeguarding tax on imports drives companies to seek avenues of shifting to localisation.

7. Required Government Support

- **Concessional Financing:** Government should work with commercial banks to develop cheap financing (debt financing with less than 10% interest rate) for emerging entrepreneurs engaged in local manufacturing of OGS products; for example, Kenya government can consider restructuring existing Youth Empowerment Fund to also benefit local manufacturers.
- **Subsidised rates:** Government should provide land and energy for local manufacturing and assembly at subsidised rates.
- **Solar Economic Zones (SEZ):** Government should introduce solar economic zones.
- **VAT exemption:** Government should reinstate 16% VAT exemptions in the Finance Bill, on specialised equipment for solar and wind energy development and production (battery, inverters, and charge controllers) that serve as ingredients for off-grid refrigerators.

8. Potential of Industry Support and Partnerships

- **Favourable local manufacturing and assembly:** Advocacy for favourable local manufacturing and assembly through EAC Bloc.
- **Awareness Campaign:** Stakeholders should collaborate to design and execute awareness campaigns and marketing to increase consumer awareness.

Conclusion

In India and Kenya, the solar commercial refrigerator market is still in its infancy. Because of significant government support, the solar walk-in cold room market in India is far more developed than in Kenya. Solar with PCM technology for solar walk-in cold rooms is popular in India and is expected to take the lead soon. In India, solar commercial refrigerators use an electrochemical battery whose future will be governed by EV adoption. In Kenya, the majority of players use solar with an electrochemical battery for both appliances.

Kenya is mainly dependent on imports of fully constructed units, whereas India primarily sources its components locally. Kenya imports the majority of the parts needed for solar walk-in cold room and solar commercial refrigerators, whereas India make their own locally. The refrigeration system's primary component, the compressor, is still imported by both Kenya and India. Kenya needs to take measures to promote local assembly / manufacturing of key components similar to India, which is advancing in this direction with some businesses starting to build manufacturing facilities for the production of compressors.

In comparison to Kenya, India has a greater potential for localisation. To enable scale-up and a shift toward localisation, India must address issues including a lack of demand and an increase in local taxation. To encourage localisation of manufacturing, Kenya must put emphasis on creating favourable fiscal conditions, such as uniform tariffs for energy equipment and further tax reductions on solar-powered products.

Chapter 3: Economic assessment of solar walk-in cold rooms and solar commercial refrigerators

To better understand the realities of promoting localisation, a systematic economic analysis was undertaken. The economic analysis was conducted for the off-grid solar refrigeration application identified under market assessment having high potential for localisation. For instance, a solar walk-in cold room with 5 tonnes capacity using PCM technology was identified as a use case with high potential for localisation to undertake detailed economic assessment for India.

The analysis focused on understanding the below at appliance level and at plant level:

1. Cost breakup for different manufacturing types and localisation levels
2. Effect of different technologies on the cost of appliance
3. Impact of COVID-19 on appliance cost
4. Key factors contributing to change in cost with increased localisation
5. Possible interventions to minimise the effect of these key factors

The appliance-level analysis includes:

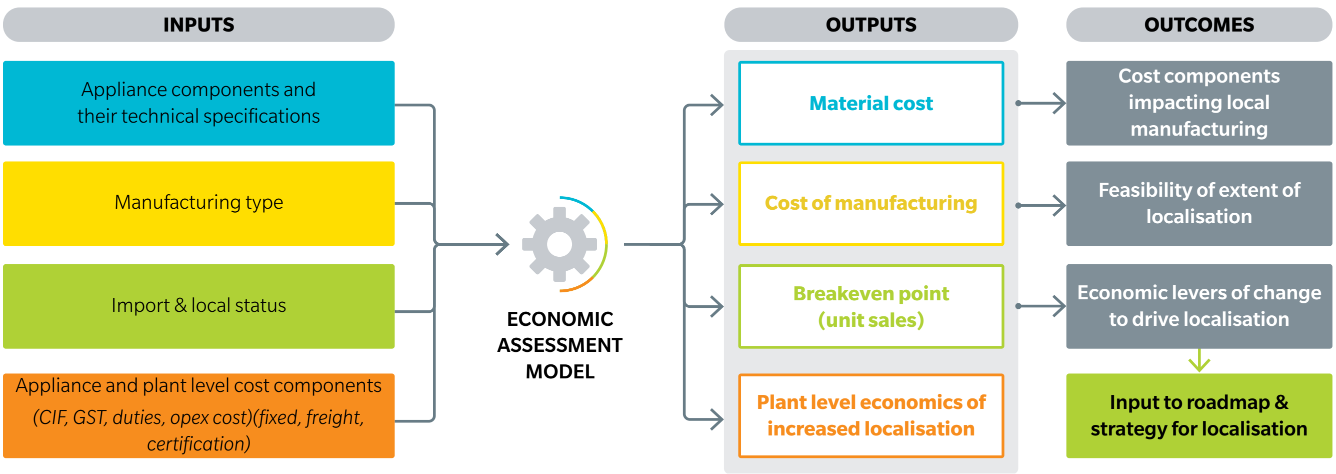
- Identifying the bill of materials (BoM) for the off-grid refrigeration appliance under consideration and cost of components for different sourcing types (import and local sourcing; CBU, SKD & CKD)
- Modelling different manufacturing types based on percent of localisation and comparing the cost of appliance in three manufacturing types
- Comparing cost of appliance with different technologies of energy storage
- Modelling impact of COVID-19

The plant-level analysis includes:

- Conducting financial analysis of plant based on open-source company financials
- Identifying the breakeven point for increased localisation scenarios
- Identifying the breakeven point for reduced taxes on the raw material

The below framework was used for carrying out the economic assessment of localisation considering the above mentioned two levels:

Figure 28: Economic Assessment Framework



Methodology used:

- A mix of primary and secondary research was conducted to collect data for bill of material and associated costs like local taxes, import taxes, freight, manpower costs, conversion costs, margins and others.
- The economic assessments at appliance level and plant level were also validated by financial experts (Chartered Accountants) and existing manufacturers from India and Kenya. This review included the components of fixed and variable costs, existing taxes levied on import and exports and possible tax reductions to support localisation and so on.

- The exchange rate used for USD to EURO conversion is 1 USD=0.95 EURO.

Limitation of the analysis:

- Due to lack of data, plant level economic assessment could not be carried out for Solar Commercial Refrigerator for both India and Kenya. Only appliance-level assessment could be done.
- Due to lack of data, because of its confidentiality and sensitivity the numbers for Kenya for solar walk-in cold room have been assumed similar to India with changes in the material cost to conduct economic analysis.

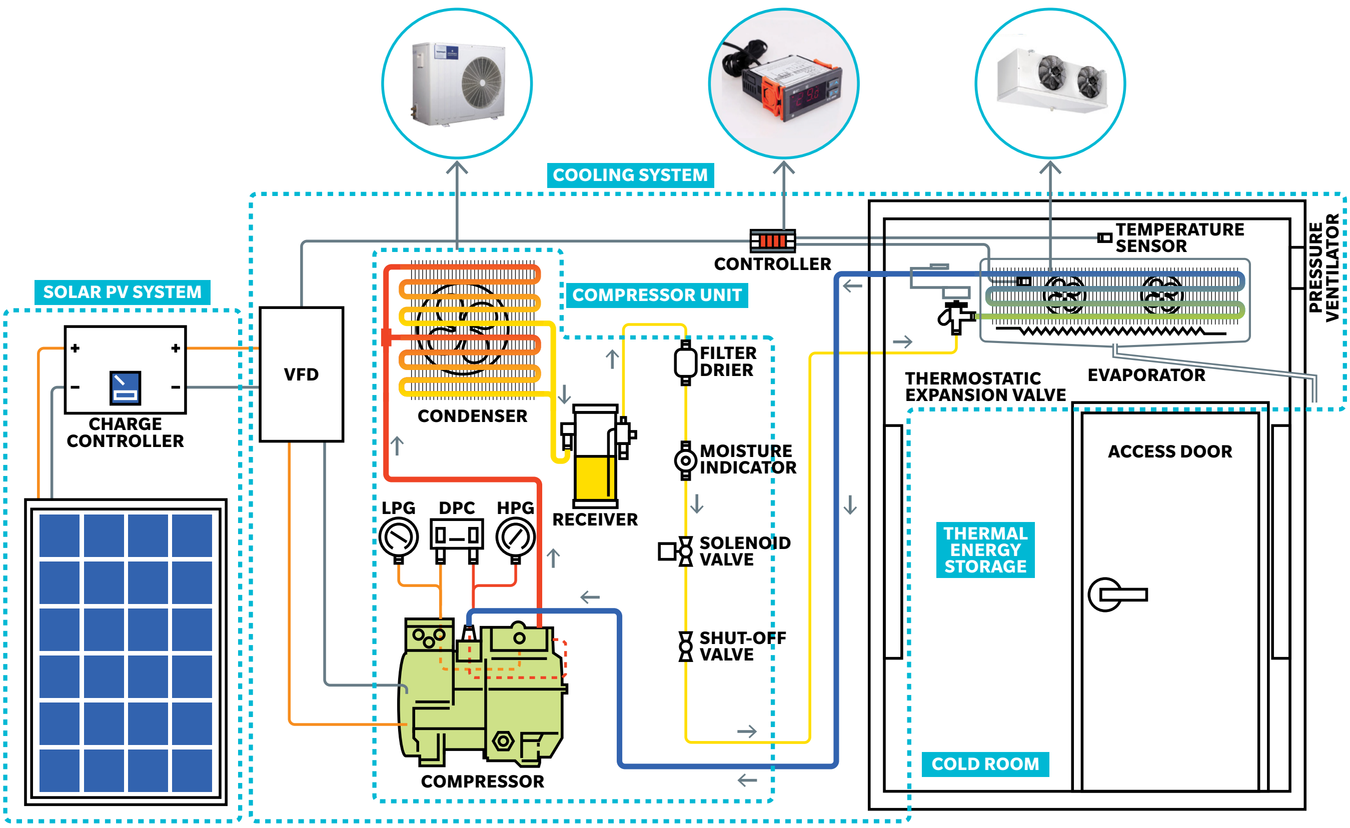
Economic Assessment of solar walk-in cold rooms

Before diving deep into the appliance level economic assessment, it is important to understand the components that form the bill of materials for solar walk-in cold rooms as shown below:

A solar walk-in cold room consists of four major systems:

1. **Solar PV system:** This is the entire solar-based generation system which includes solar panels, mounting structure for panels, charge controller and remaining balance of system. In all the scenarios of localisation, the solar PV system is assumed to be locally sourced.
2. **Cooling system:** This includes the refrigeration system which broadly includes compressor unit including condenser, evaporator unit, expansion valve and controller. In the first scenario this is assumed to be imported as a completely built unit, while as the localisation increases the individual components are assumed to be sourced (either local or imported) and assembled increasing the local value addition.
3. **Thermal energy storage:** This includes the system of eutectic salt-based PCM plates for storing energy. This is assumed to be imported in all scenarios except for the completely localised scenario. Thermal energy storage is the predominant technology of energy storage used presently in India. However, a scenario with a battery energy system is also modelled for comparison.
4. **Cold room chamber:** This includes the cold room envelope including the thermal insulation (PUF panels). This is assumed to be locally sourced in all scenarios.

Figure 29: Components of solar walk-in cold room



India

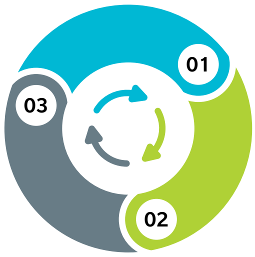
Appliance-Level Assessment

The appliance-level analysis is conducted for solar walk-in cold rooms with PCM technology with below specifications since it was identified as the potential off-grid solar refrigeration use case for localisation as per market assessment:

PARAMETER	SPECIFICATION
Capacity	5 tonnes - (20*8*8) ft
Temperature	1-11°C
Solar Power Rating	5kWp
Backup	Thermal Energy Storage (TES) using PCM (Eutectic salt solution)

The economic assessment compares the M2 (including different levels of localisation) and M3 localisation scenarios. M1 is currently not available, hence not analysed and compared.

Figure 30: Localisation scenarios compared for economic assessment



M1 The appliance is imported as a Completely Built Unit (CBU)
Currently Not Available

M2 The appliance is manufactured / assembled by partially importing and local sourcing of components Economic Assessment is carried out for 3 scenarios as below:
50% Localisation: *Both Cooling system and TES are imported*
75% Localisation: *Cooling system locally assembled (compressor unit imported)*
85% Localisation: *Compressor unit locally assembled (partial import of components of compressor unit)*

M3 The appliance is manufactured by 100% local sourcing of components
Desirable

Table 6 indicates the components that are assumed to be locally sourced in the four different scenarios considered.

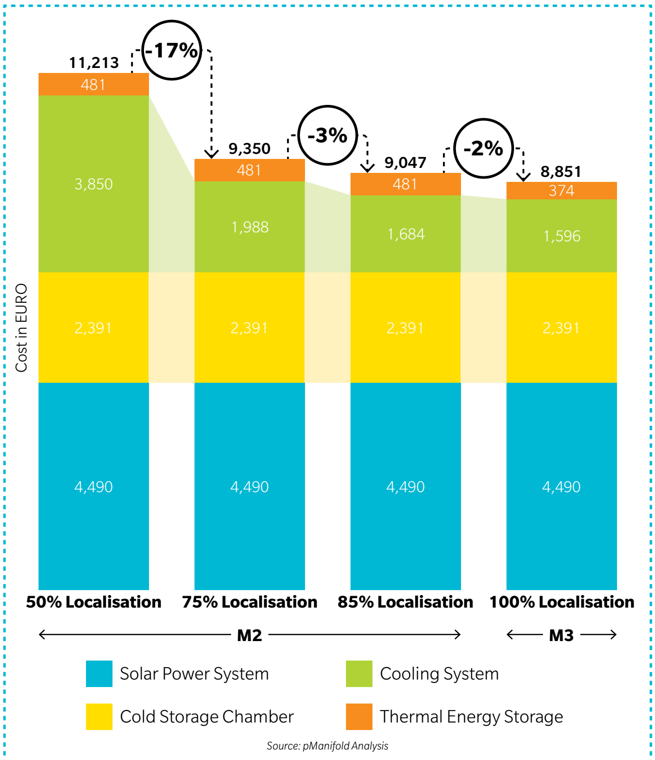
Table 6: Solar walk-in cold room components localised across different localisation scenarios for India

SN	COMPONENTS	50% LOCALISATION	75% LOCALISATION	85% LOCALISATION	100% LOCALISATION
		BOTH COOLING SYSTEM AND TES ARE IMPORTED	COOLING SYSTEM LOCALLY ASSEMBLED (COMPRESSOR UNIT IMPORTED AND TES LOCALLY DESIGNED & SOURCED)	COMPRESSOR UNIT LOCALLY ASSEMBLED (PARTIAL IMPORT OF COMPONENTS OF COMPRESSOR UNIT)	ALL COMPONENTS LOCALLY SOURCED AND ASSEMBLED
1	**Solar panel**	✓	✓	✓	✓
2	**Charge controller**	✓	✓	✓	✓
3	**Solar mounting structure**	✓	✓	✓	✓
4	**Balance of System**	✓	✓	✓	✓
5	**Cooling system (CBU)**				
	Compressor unit				
	Compressor				✓
	Sight glass			✓	✓
	Liquid receiver			✓	✓
	Suction accumulator			✓	✓
	Oil separator				✓
	Filter drier			✓	✓
	Pressure controller			✓	✓
	Vibration absorber			✓	✓
	Condensing unit (Heat exchanger and fan without compressor)			✓	✓
	Solenoid valve			✓	✓
	Evaporator unit (Heat exchanger, fan)		✓	✓	✓
	Variable frequency driver			✓	✓
	Control Board (Including LCD controller)		✓	✓	✓
	Electronic expansion valve				✓
	Pressure Sensor		✓	✓	✓
	Temperature Sensor		✓	✓	✓
6	**TES blocks / panels**				✓
7	**Cold room**	✓	✓	✓	✓

Breakdown of Bill of Material (BoM) costs for different localisation scenarios

As seen in Figure 31, the material cost contributes to 40-50% of the end-user price (called as Market Retail Price (MRP)) for a solar walk-in cold room. Since the solar power system and cold storage chamber are locally sourced in all scenarios, it is only the cooling system that affects the change in overall costs. Moreover, the cost of procuring the cooling system is highest for 50% localisation case which makes the overall system procurement cost higher for 50% localisation scenario. As the localisation is increasing the material procurement cost is decreasing, lowest being under the 100% localisation scenario. There is significant BoM cost reduction (17%) from 50% to 75% localisation due to reduction in cooling system cost due to partial local sourcing while there is minimum rate of decrease in the BoM cost from 75% to 85% and further to 100% (theoretical maximum) due to insignificant changes in the cooling system components and sub-components costs (like sight glass, oil separator).

Figure 31: Breakdown of BoM cost across different localisation scenarios



The total MRP of the appliance includes the material sourcing cost, value-added labour costs for marketing and assembly, and Goods and Services Tax (GST). The solar walk-in cold room's MRP breakdown is shown in Figure 33. Despite the fact that material costs fall as localisation increases, the overall MRP does not follow the same pattern. This is due to a change in the appliance's overall conversion costs. The conversion cost increases as more value addition / assembly of components is done locally. The cost of conversion comprises both Fixed Costs (machines and other infrastructure) and Variable Costs (labour + electricity) for putting together individual parts to create a subsystem. The plant-level economic analysis investigates these conversion costs in further detail.

With increased localisation, the foreign exchange fees (paying more for imports) is limited. As seen in Figure 32, the transition from 50% to 75% localisation results in a reduction of ~57% foreign exchange. A further 40% is reduced for 85% localisation.

Figure 32: Impact on foreign exchange

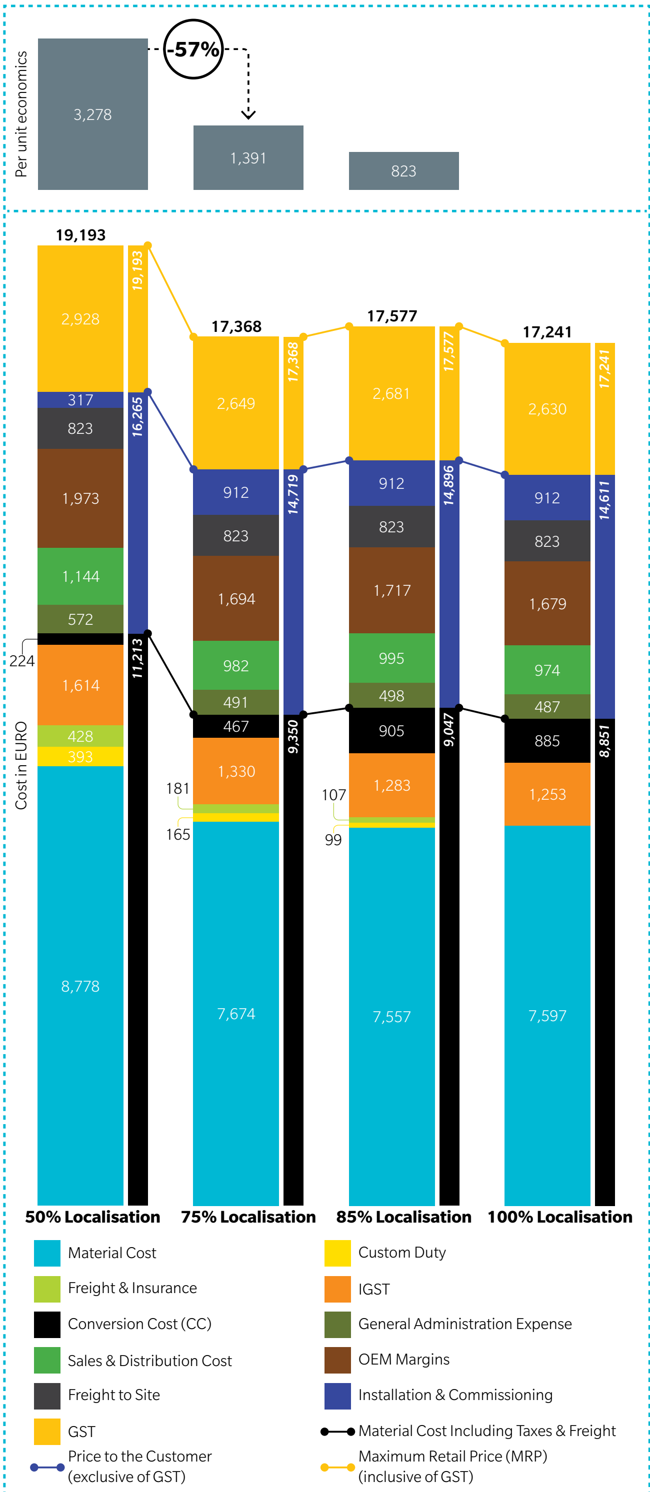


Figure 33: MRP Breakdown of solar walk-in cold room for different localisation scenarios

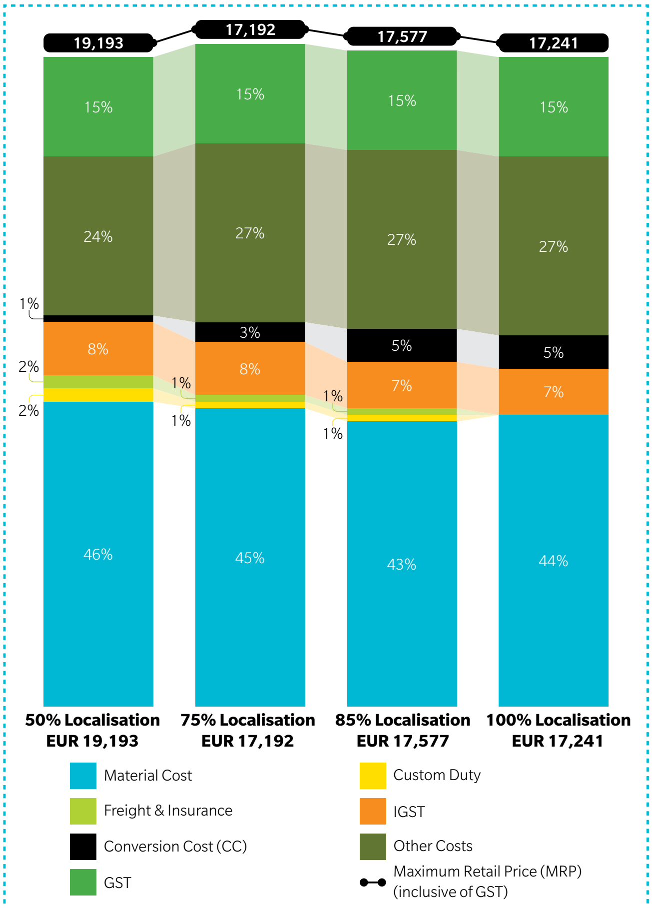
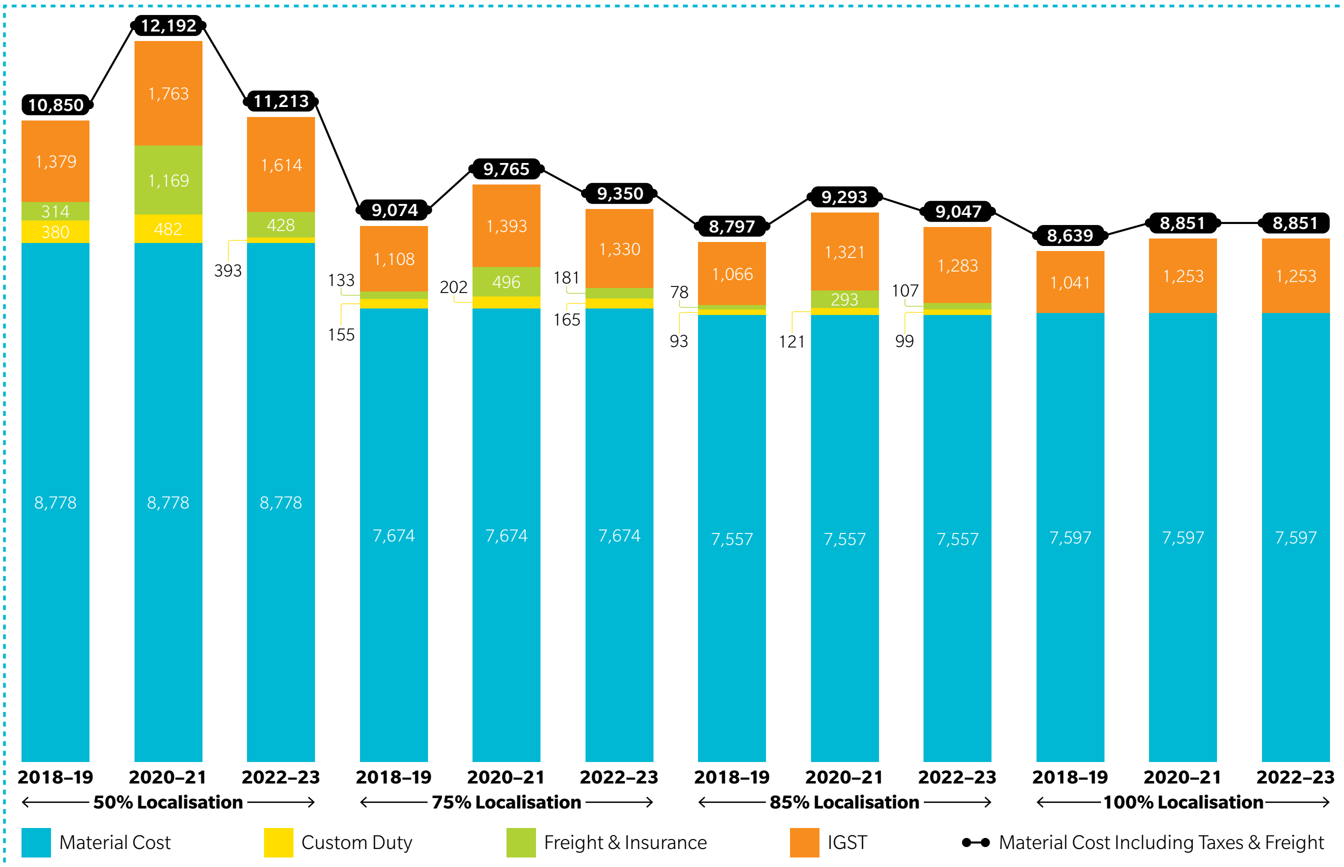


Figure 34: Impact of COVID-19 on the appliance MRP cost



Impact of COVID-19 on the appliance cost

The COVID-19 epidemic had an impact on global and local supply networks, and the solar off-grid industry was no exception. The impact of COVID-19 is examined for pre-COVID timeframes (2018-19), during lockdowns (2020-21), and after lockdown restrictions were lifted (2022-23) as shown in Figure 34. According to stakeholder interviews, the impact of COVID-19 was mostly on freight costs, which have gradually returned to normal. Analyses show that as localisation increases, the impact of freight costs decreases dramatically as import dependency reduces. The variation in overall expenses is greater in the case of 50% localisation.

Effect of use of different energy storage technologies

The solar walk-in cold room cost differs with the different energy storage technologies. On analysing the impact of technology for 75% localisation scenario, use of battery energy storage such as a Tubular Lead Acid Battery (21kWh, 12V, 250 Ah) instead of the PCM technology results in an increase in overall procurement cost of the materials by ~13%. The cost of battery storage is assumed to be approximately EUR 1,460 (USD 1,493) while that of TES blocks for PCM technology is assumed to be approximately EUR 318 (USD 333). The 13% increase in the material cost will result in an increase in the MRP of the solar walk-in cold room to EUR 1,915 (USD ~2,000).

- MRP of cold room with PCM technology is about EUR 17,368 (USD 18,285)
- MRP of cold room with batteries is about EUR 19,318 (USD 20,339)

Plant-Level Economic Assessment

The plant-level economic assessment is carried out for a 5 tonne solar walk-in cold room employing PCM technology using publicly available financial and profit and loss statements of a key player of WICR in India. The OEM player considered is currently under the 75% localisation scenario. The operating costs and the revenue of the OEM are used to estimate the breakeven point of the plant. The breakeven is calculated as below:

Breakeven = Fixed cost/(1-(Variable cost/revenue)

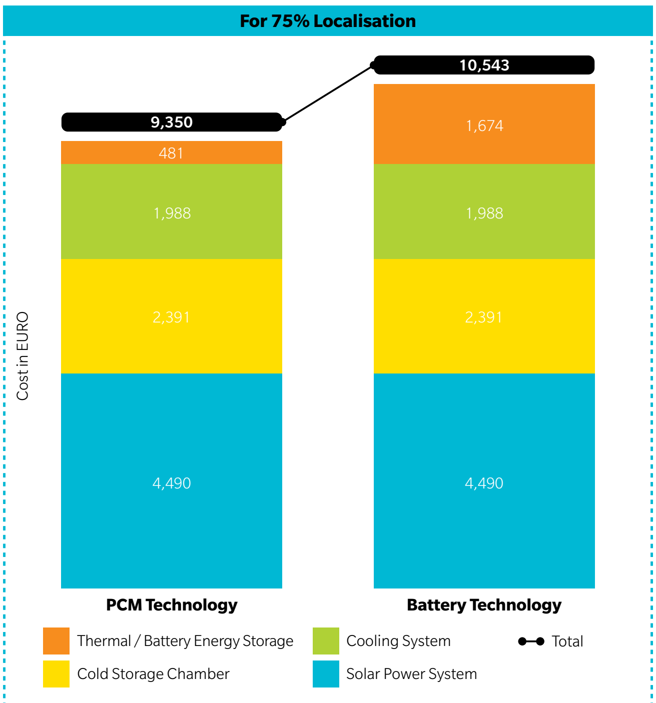
The breakeven point will give the value of minimum number of unit sales an OEM has to make, to make the business profitable. The breakeven point will act as a reference point to assess the overall operational viability of the plant considering the present market for the appliance.

The operating costs of an OEM consists of fixed and variable costs:

- Fixed costs: These are the recurring costs that a company must incur every year as part of the operations. These costs are time dependent and remain the same for a particular year irrespective of the production volumes. Different cost categories under fixed cost include annual rent, salaries to the permanent employees, cost of finance, depreciation and amortisation on assets, insurance expense and others
- Variable costs: These are the costs incurred as part of operation cost which will vary as per the changes in level of production. These costs are incurred as and when any units are produced. Different cost heads under the variable costs include material costs, outbound freight costs and other plant costs like labour, electricity and other maintenance costs

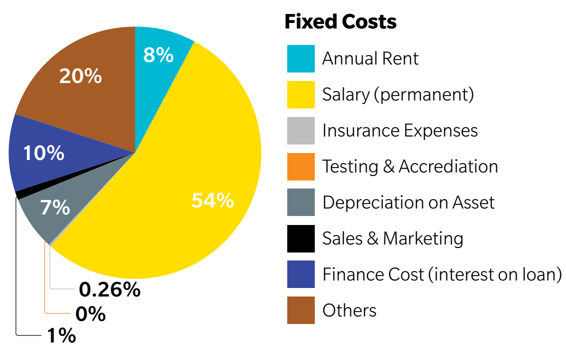
As per analysis, salaries to the employees form the major portion (54%) of the fixed costs, while the material cost is the major component (98%) of variable cost as shown in Figure 36. Other costs under fixed costs include software subscription expenses, telephone and internet expenses, housekeeping and security, R&D expenses, general office expenses and others.

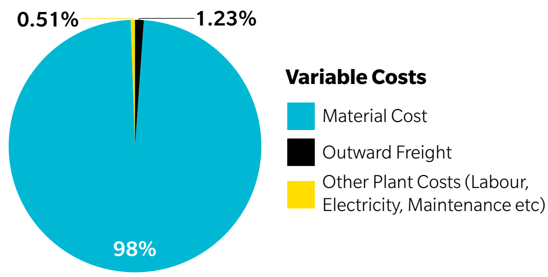
Figure 35: Material costs per unit



Generally, variable cost is more than fixed cost. For the purposes of this analysis, it has been assumed that the ratio of variable cost to fixed cost is 2:1.

Figure 36: Fixed and Variable Costs incurred under 75% localisation scenario

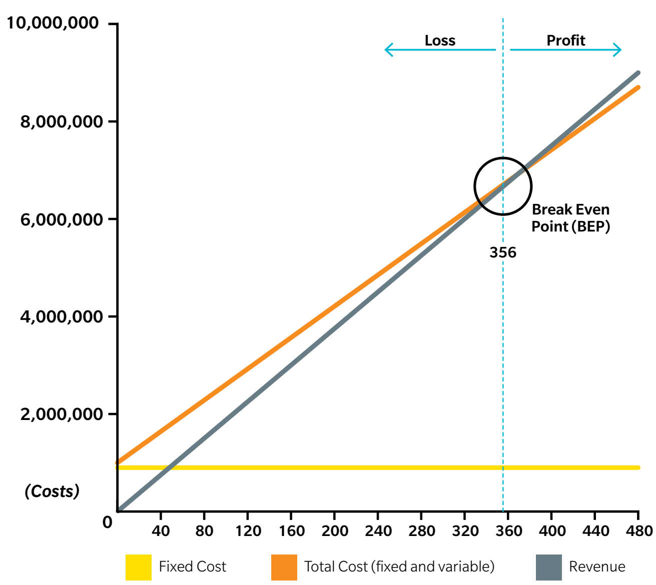




The investments to procure land and machinery are not considered directly (rather considered as monthly rent assuming the land to be on lease) for estimating the breakeven point, rather the depreciation on the assets procured and cost on finance to procure the assets have been considered under the fixed cost component. With these assumptions and the values from the company financials, the breakeven for the company to make profits is obtained. This breakeven is the sales in dollars that OEM must make to make the business profitable.

Then the cost of appliance from the appliance level analysis for the 75% localisation scenario is used to estimate the number of units to be sold for profitable operation. Figure 37 shows the breakeven point for the plant.

Figure 37: Plant-level breakeven analysis



The breakeven analysis shows a minimum 356 units of WICRs to be sold annually to make the business profitable.

Impact of increased localisation on plant-level economics

Similarly, the above breakeven analysis is carried out for increased localisation scenarios as shown in Table 7. As the results suggest in the appliance level analysis, the material cost decreases by 3% and 2% as the localisation is increased from 75% to 85% and 85% to 100% respectively. Considering more local value addition with increased localisation scenarios (as more components are locally assembled), the fixed costs for operating the plant will increase. The cost on assets and salaries to permanent employees are major costs that have seen an increase. (As mentioned above, for the purposes of this analysis, it has been assumed that the ratio of variable cost to fixed cost is 2:1.) So as the localisation increases the change in fixed and variable costs are shown below:

Moving towards increased localisation, the breakeven point of the manufacturing plant has come down as seen in Figure 38.

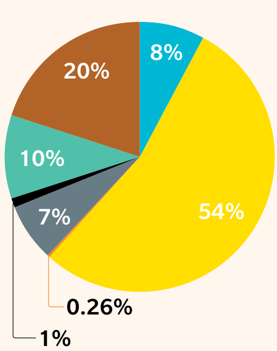
- For the 85% localisation scenario, the breakeven can be achieved at an annual production of 293 units
- For the 100% localisation scenario, the breakeven can be achieved at an annual production of 263 units

The reduction in the breakeven annual production is mostly due to the reduction in material cost. As the share of material cost is high in the variable cost component, it is directly impacting the overall breakeven point for an OEM. However, since there is a minimum difference between the variable cost for 85% and 100% localisation due to minimum difference in the BoM, the impact on breakeven point is negligible.

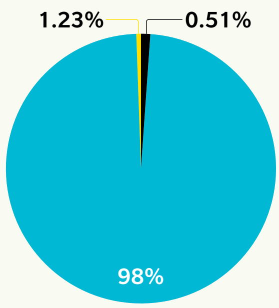
Table 7: Fixed and Variable cost incurred across different localisation scenarios for solar walk-in cold room

FIXED COSTS | **VARIABLE COSTS**

75% Localisation

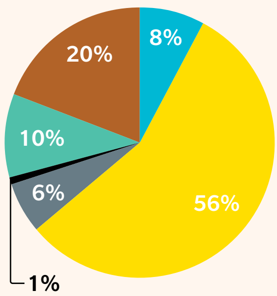


Annual Rent ***8%***
Salary (permanent) ***54%***
Insurance Expenses ***0.26%***
Testing & Accrediation ***0%***
Depreciation on Asset ***7%***
Sales & Marketing ***1%***
Finance Cost (interest on loan) ***10%***
Others ***20%***

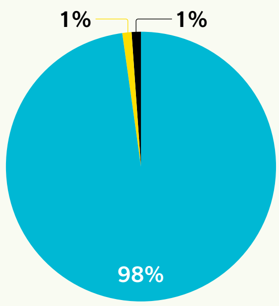


Material Cost ***98%***
Outward Freight ***1.23%***
Other Plant Costs (Labour, Electricity, Maintenance etc) ***0.51%***

85% Localisation

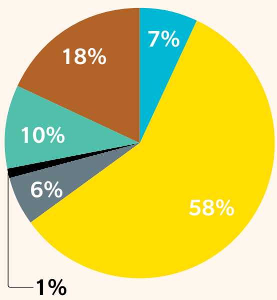


Annual Rent ***8%***
Salary (permanent) ***56%***
Insurance Expenses ***0%***
Testing & Accrediation ***0%***
Depreciation on Asset ***6%***
Sales & Marketing ***1%***
Finance Cost (interest on loan) ***10%***
Others ***20%***

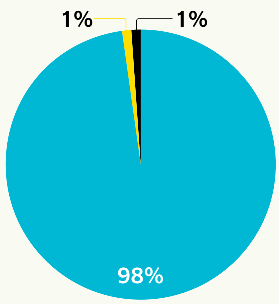


Material Cost ***98%***
Outward Freight ***1%***
Other Plant Costs (Labour, Electricity, Maintenance etc) ***1%***

100% Localisation

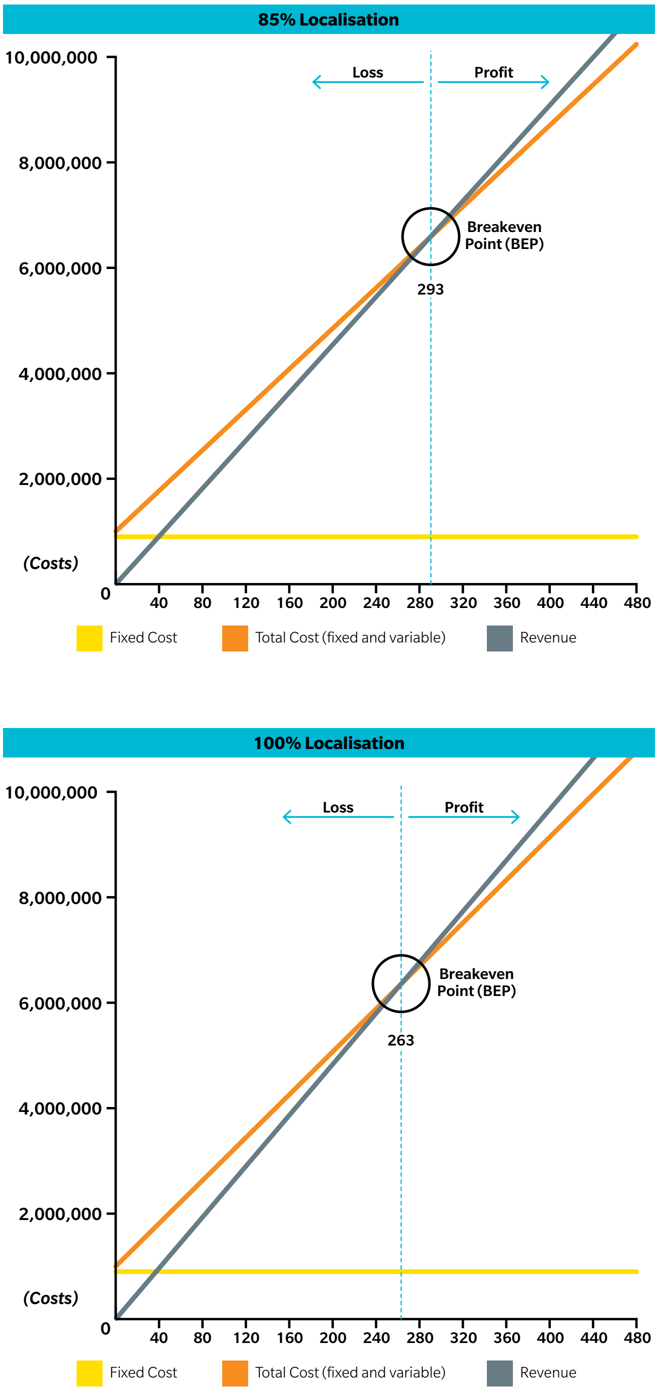


Annual Rent ***7%***
Salary (permanent) ***58%***
Insurance Expenses ***0%***
Testing & Accrediation ***0%***
Depreciation on Asset ***6%***
Sales & Marketing ***1%***
Finance Cost (interest on loan) ***10%***
Others ***18%***



Material Cost ***98%***
Outward Freight ***1%***
Other Plant Costs (Labour, Electricity, Maintenance etc) ***1%***

Figure 38: Plant-level breakeven analysis for different localisation scenarios

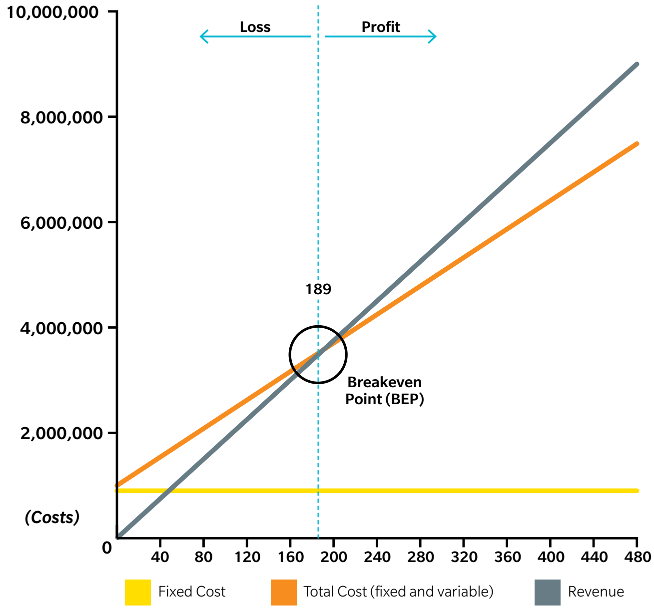


Impact of reduction in local taxes on the breakeven point

Since the material cost is a major component of the variable cost, the IGST on the raw materials for the appliance manufacturing will have a major impact on the breakeven value of the business. Currently the overall % of GST on raw material for 75% localisation scenario is 17%. The breakeven point of the business is calculated by varying the IGST applicable on the raw material for the appliance assembly, considering GST reduction from 17% to 5% for analysis purpose.

The analysis shows a fall in the breakeven point to 189 units, as the IGST is decreased from existing 17% to 5% as shown in Figure 39.

Figure 39: Impact of reduction in local taxes on the breakeven point



Kenya

Appliance-Level Assessment

The appliance-level analysis is conducted for solar walk-in cold room with battery energy storage with below specifications:

PARAMETER	SPECIFICATION
Capacity	5MT - (20*8*8) ft
Temperature	1-11°C
Solar Power Rating	5kWp
Backup	Battery Energy Storage (250 Ah x 4 Nos.)

The economic assessment compares 50% and 75% localisation scenarios under M2. Due to lack of data availability and non-feasibility for further localisation of the components, the 85% localisation scenario was not considered. M1 is currently not available and M3 is a challenging state to achieve, hence not analysed and compared.

Figure 40: Localisation scenarios considered for Kenya

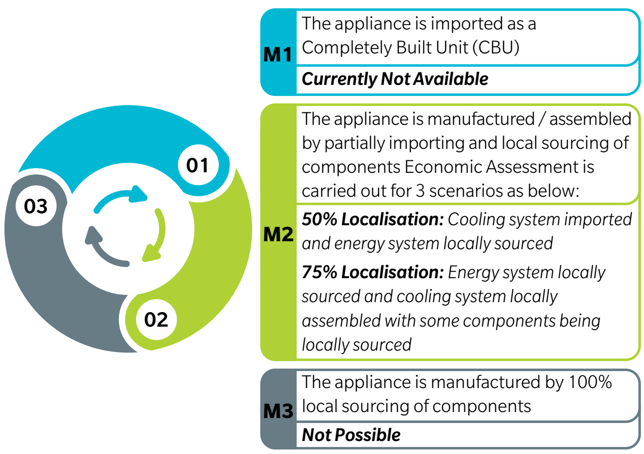


Table 8 below indicates the components that are assumed to be locally sourced in the 50% and 75% localisation scenarios:

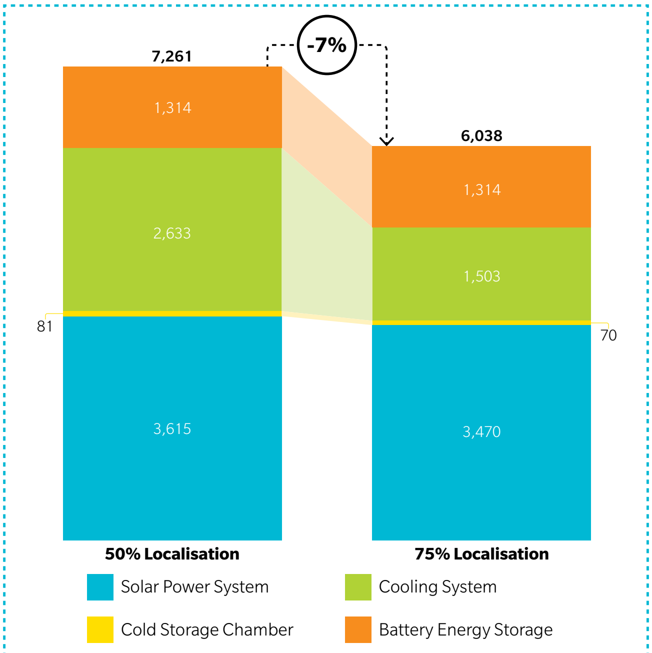
Table 8: Solar walk-in cold room components localised for different localisation scenarios

SN	MATERIAL	50% LOCALISATION	75% LOCALISATION
1	**Solar Panel**	✓	✓
2	**Charge Controller**	✓	✓
3	**Solar Mounting Structure**	✓	✓
4	**Balance of System**	✓	✓
5	**Battery Protect**	✓	✓
6	**Cooling System (CBU)**		
	Cable power for cooling unit		
	Thermostats for cooling units		
	Plate heat exchanger		✓
	Insulation for water chillers		✓
	Plug inself for water chiller		
	Glue catridge		✓
	Installation kit		✓
	Hose insulation		✓
	Water pump		
7	**Batteries**		
8	**Cold Storage Chamber**	✓	✓

Breakdown of Bill of Material (BoM) costs for different localisation scenarios

As seen from Figure 41, the analysis of BoM costs shows that the material cost contributes to 40-43% of the end-user price (called as Market Retail Price (MRP)) for a solar walk-in cold room. Similar to India, since solar power systems and cold storage chambers are locally sourced in all scenarios, a change in cooling system costs impacts a change in overall material cost. Moreover, the cost of procuring the cooling system is highest for the 50% localisation case which makes the overall system procurement cost higher for the 50% localisation scenario.

Figure 41: Breakdown of BoM costs for solar walk-in cold room in different localisation scenarios for Kenya



Similar to India, despite the fact that material costs are falling as localisation rises, the overall MRP doesn't follow the same pattern. This is also due to a change in the appliance's overall conversion costs (increases from EUR 513 to 1,253 i.e. USD 538 to 1,314). The conversion cost increases as more value addition / assembly of components is done locally. Moreover, an increase in localisation from 50% to 75% reduces the foreign exchange by ~60% as shown in Figure 42.

Figure 42: Impact of localisation on foreign exchange

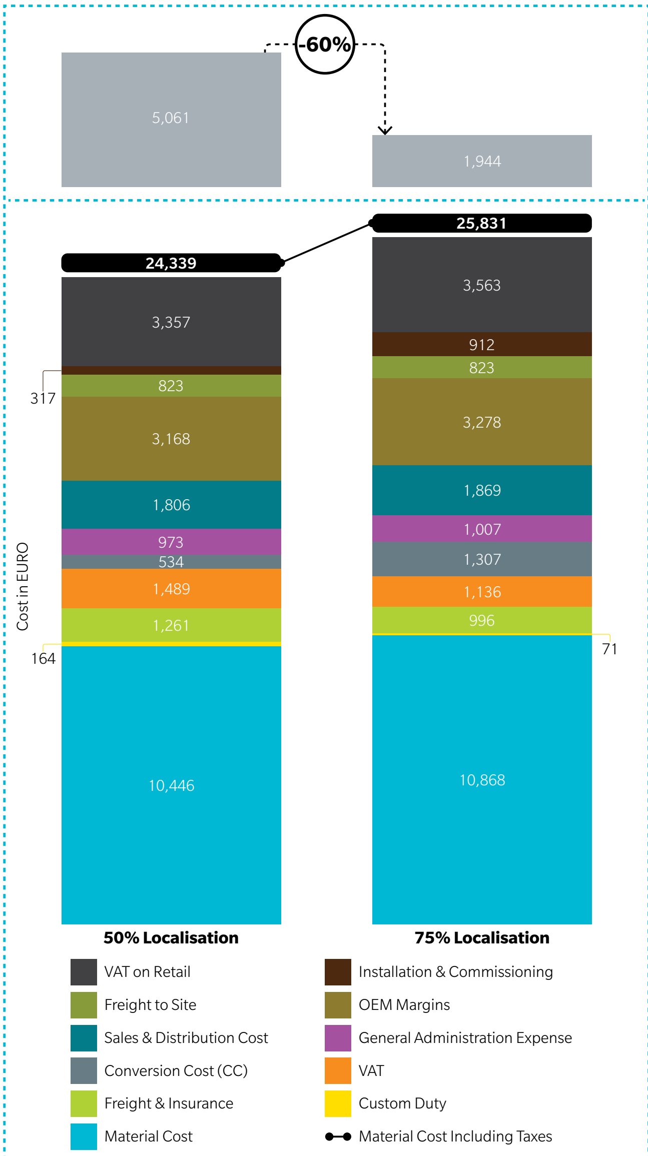
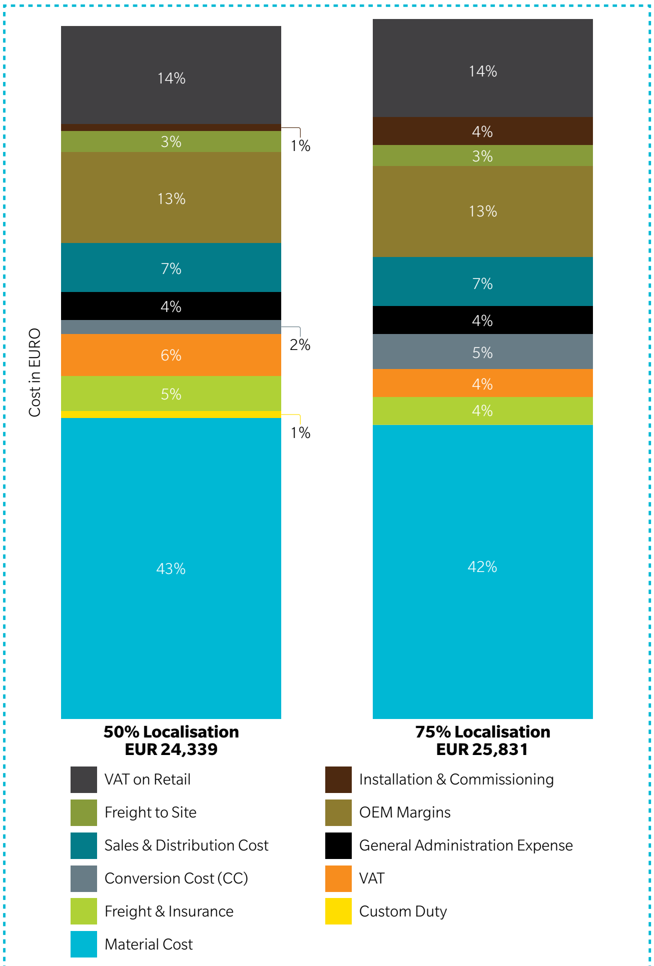


Figure 43: MRP breakdown for solar walk-in cold room for Kenya



Effect of use of different energy storage technologies

The MRP of solar walk-in cold rooms with PCM technology is EUR 23,328 (USD 24,555) while that using battery technology is EUR 24,339 (USD 25,620).

Impact of COVID-19 on the appliance cost

Similar to India, Kenya also faced supply chain issues and a significant impact on the appliance costs due to a rise in the freight cost.

Plant-Level Economic Assessment

The approach for the plant-level economic assessment was similar to India but done for the 50% localisation scenario since this is a more prevalent localisation scenario in Kenya. Due to a lack of data availability and profit & loss statements for Kenya, certain assumptions were made in line with India data points to arrive at plant-level economics.

Similar to India, employee salaries form the major portion (40%) of the fixed costs, while the material cost is the major component (99%) of variable cost as shown in Figure 45. Other costs under fixed costs include software subscription expenses, telephone and internet expenses, housekeeping and security, R&D expenses, general office expenses and others.

Figure 44: Impact of COVID-19 on the appliance MRP cost

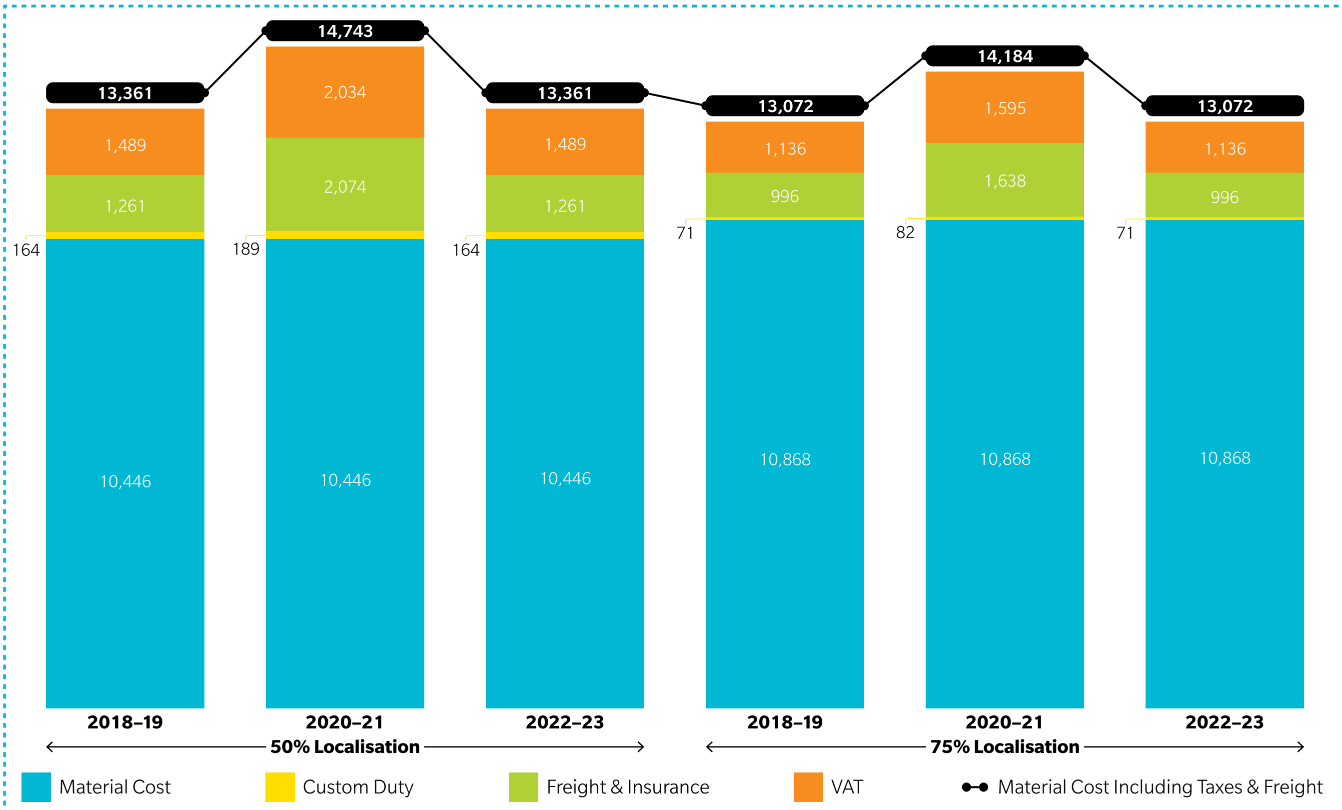
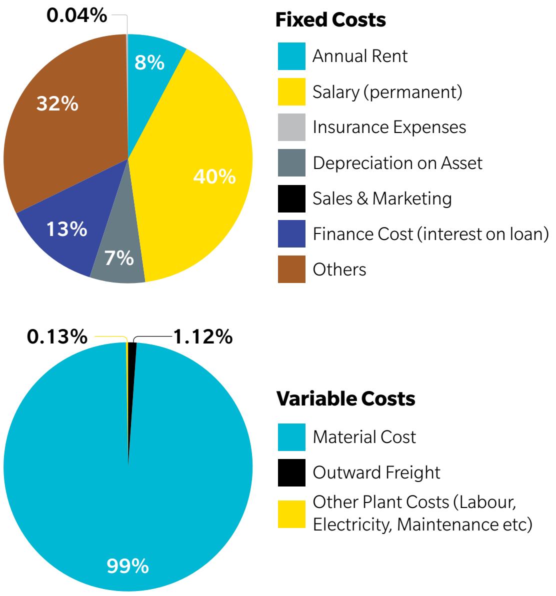
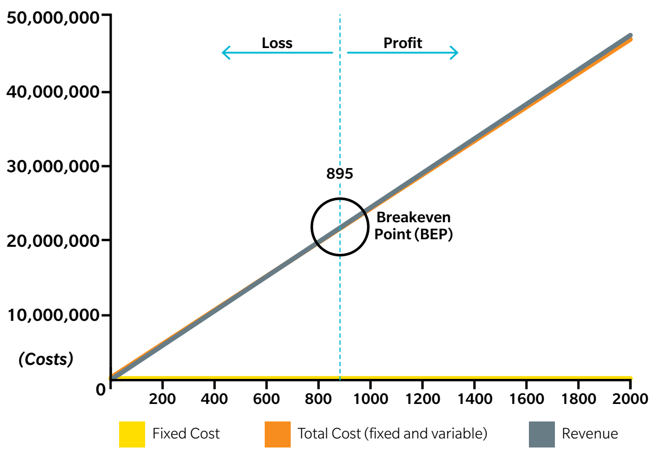


Figure 45: Fixed and Variable cost incurred for the 50% localisation scenario for solar walk-in cold room in Kenya



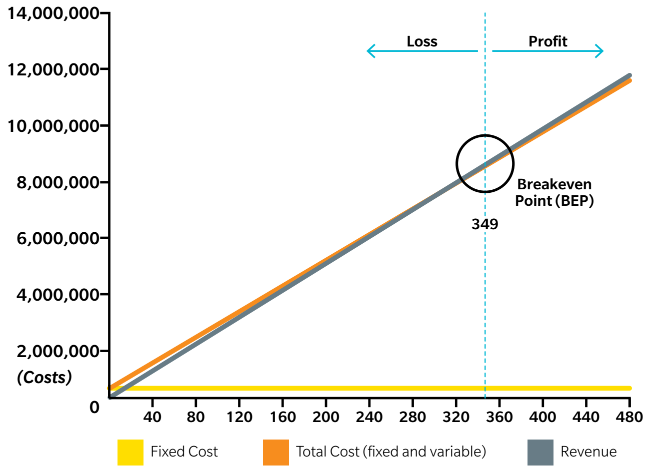
Further, the breakeven analysis was conducted for a 5MT walk-in cold room assembly line similar to India as shown in Figure 46. It was found that Kenya needs much higher number of sales units to achieve breakeven for 50% localisation compared to India given the nascency of the industry and associated high costs as shown below:

Figure 46: Plant-level breakeven analysis for 50% localisation scenario



However, with increased localisation (i.e., 75%) , Kenya businesses can achieve breakeven at dramatically lower sales of units (349 units annually compared to India's 356 units annually) as shown in Figure 47. As per analysis, this is driven by reduction in the material costs with increase in localisation and reduction in import dependency leading to reduced import duties. However, to make this a reality, a number of fiscal and non-fiscal measures will be required to support the growth of the industry and eventually towards localisation.

Figure 47: Plant-level breakeven analysis for the 75% localisation scenario



Conclusion

Local manufacturing of solar walk-in cold rooms is feasible if is matched by adequate corresponding demand. The demand requirement to meet breakeven decreases with increased localisation since material cost is reduced which is a major component of variable cost. Material cost decreases with increased localisation due to reduction / elimination in import duties and taxes. Increased localisation reduces breakeven volume demand; however, it is matched by increased capital cost requirement to build and procure asset. Increased capital cost investment is a significant factor demotivating OEMs to shift to higher localisation. Thus, fiscal incentives in this regard (front-end subsidies) could play a major role to ensure local manufacturing / assembly.

Chapter 4: Economic assessment of solar commercial refrigerators

The economic assessment of Solar Commercial Refrigerators includes an appliance-level assessment for India. Due to lack of data availability and sensitivity around BoM costs the analysis was limited to India.

India

Appliance-level assessment

The appliance-level assessment was conducted for Solar Commercial Refrigerators with battery technology with the below specification for India:

PARAMETER	SPECIFICATION
Capacity	200L
Temperature	1-11°C
Solar Power Rating	3*150 Wp
Backup	Battery

The economic assessment compares below M1, M2 (including different levels of localisation) and M3 localisation scenarios.

Figure 48: Localisation scenario analysed for appliance-level assessment of Solar Commercial Refrigerator

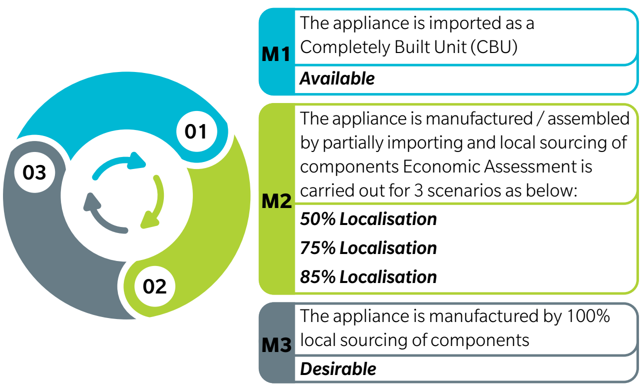


Table 9 indicates the components that are assumed to be locally sourced in the different localisation scenarios:

Breakdown of BoM costs for different localisation scenarios:

As seen from Figure 49 below, the cooling system accounts for 30-5 0% of the BoM costs. Similar to solar walk-in cold rooms, with increased localisation the conversion cost increases for solar commercial refrigerators resulting in an increase of the overall appliance cost.

Figure 49: Breakdown of BoM costs for different localisation scenarios for Solar Commercial Refrigerator

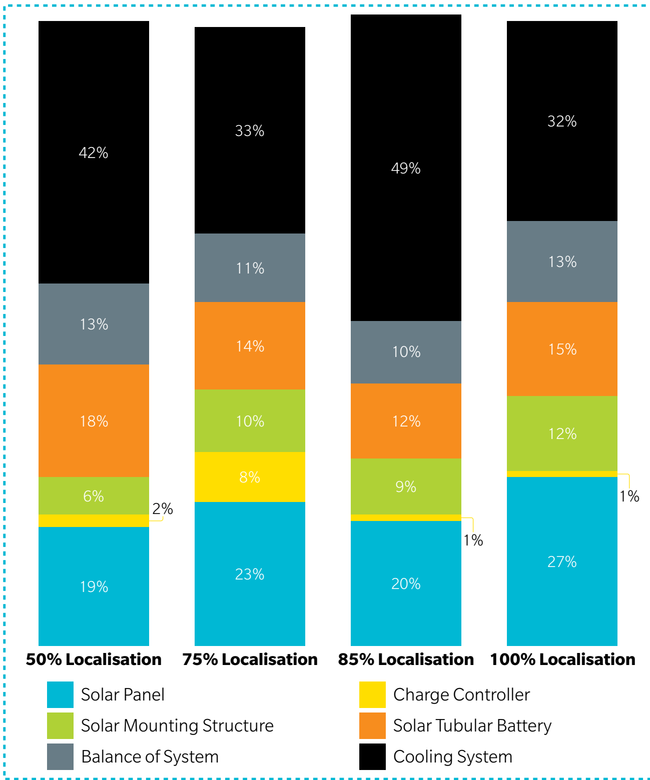
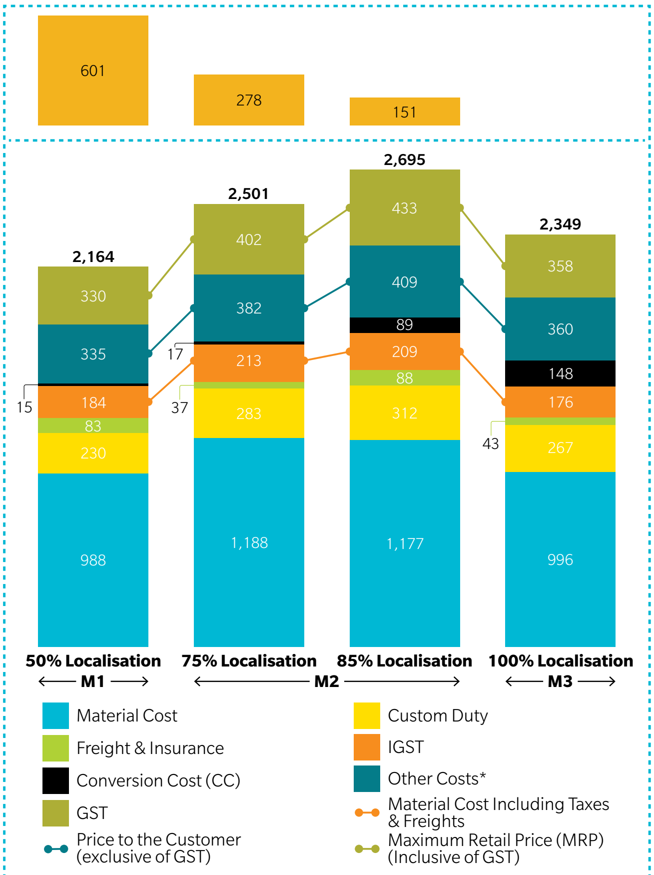


Table 9: Solar Commercial Refrigerator components localised across different localisation scenario for India

MATERIAL	50% LOCALISATION	75% LOCALISATION	85% LOCALISATION	100% LOCALISATION	MATERIAL	50% LOCALISATION	75% LOCALISATION	85% LOCALISATION	100% LOCALISATION
Solar Panel		✓	✓	✓	Filter drier			✓	✓
Charge Controller		✓	✓	✓	Condensing unit (heat exchanger and fan)			✓	✓
Solar Mounting Structure		✓	✓	✓	Evaporator coils			✓	✓
Balance of System		✓	✓	✓	Control Board (including LCD controller)			✓	✓
Battery Protect	✓	✓	✓	✓	Expansion valve			✓	✓
Cooling Unit			✓	✓	Pressure Sensor			✓	✓
Compressor and controller card				✓	Temperature Sensor			✓	✓
Oil separator			✓	✓					

The appliance cost is higher at 85% localisation as shown in Figure 50 as it involves assembly of individual parts to form a sub-system and eventually the appliance. While at 100% localisation there is a significant reduction in the appliance cost due to a reduction in import duties on key components like compressors. Additionally, with increased localisation the foreign exchange reduces by ~54% when transitioning from 50% to 75% localisation.

Figure 50: Impact of localisation on foreign exchange



Key recommendations

The Indian off-grid solar refrigeration appliance market is more developed than the Kenyan market and requires strong policy support to grow and shift toward localisation. As a result, for Kenya to shift toward localisation, more efforts on the ground are needed to develop the local ecosystem, such as capacity building, skill development, removing anomalies in the import duty structure, tax exemptions and demand creation.

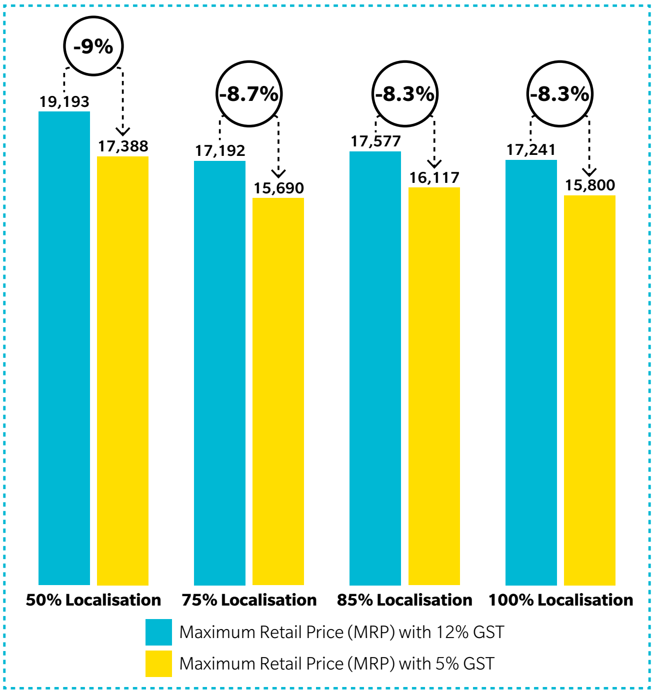
While making recommendations involving fiscal matters to policymakers, it is important to estimate the impact, positive or negative, on fiscal revenue. While making recommendations related to providing fiscal incentives to promote a certain intervention, in this case, local assembling and manufacturing, it is also important to quantify the opportunity cost of additional fund requirements. The quantification of such impacts is outside the scope of this research, nevertheless, the research team recommends the following list of fiscal and non-fiscal measures to help accelerate industry towards localisation.

Fiscal measures for increased localisation

1. **Reduce or exempt local taxes on the appliance and their components**

As per findings from the economic assessment, local tax impacts the economic feasibility of OSGR appliance. In India, the effective GST on solar walk-in cold room and Solar Commercial Refrigerator is currently ~14%. To facilitate localisation, it is recommended to reduce GST to 5% not only on the finished appliance but also on its components. For example, reduction of GST from 12% to 5% on solar walk-in cold room components helps reduce the cost of the appliance by 8-9% as shown in Figure 51 and also helps in achieving breakeven at lower sales volumes. Additionally, OEMs should be granted tax holidays for the next 4-5 years.

Figure 51: Impact of reduction on local taxes on appliance cost



On June 30th, 2021, the Kenyan government passed the Finance Act, 2021 into law, reinstating 16% VAT exemptions on renewable energy products including off-grid refrigerators and cold storage. However, off-grid companies have to go through a long and bureaucratic process to get the exemption certificate. Some companies have also pointed out a few solar products such as complete built off-grid refrigerators are not well defined under the current Harmonised System (HS Codes), the numerical method used by customs officials in classifying and assessing duties and taxes for traded products. The combination of all these has led to the majority of private sector actors giving up utilising the exemption benefit.

Amid this situation, VAT is charged (even though legislation suggests otherwise) on complete built units of off-grid refrigerators and integral components such as charge controllers, batteries and solar panels. The study also found that VAT is levied on all other components making up solar walk-in cold rooms such as TES panels, DC pumps, heat exchangers and compressors, therefore increasing the cost to the consumer.

If the country is to make strides towards local manufacturing of off-grid refrigerators it is imperative to streamline processes to get VAT exemptions for off-grid components and waive VAT charges for all other components necessary for manufacturing solar walk-in cold rooms.

2. Increase import duties on import of completely built units

One of the crucial components to enable the growth of a nation's localisation ecosystem is implementing higher import duty. To assist local assembly / manufacturing and to also help lower the cost of the appliance, it is advised that in India higher Basic Customs Duty (BCD) be applied to imported completely built units (CBU) while none should be applied to imported components for both solar walk-in cold room and Solar Commercial Refrigerator. To minimise any incompatibility with WTO regulations, it is also advised that the GST decrease, and BCD increase be implemented in stages.

In Kenya, while custom duty exemption for solar equipment is an encouraging step, other imported components of solar walk-in cold room e.g., TES blocks / panels, installation kit, insulation for water chillers etc. are charged with import duty in the range of 10%-30%. To reduce cost for consumers and hence stimulate local assembly customs duty waivers should be extended to these components as well. It is understood customs duties in Kenya are under jurisdiction of East Africa Community common external tariff regime and therefore any meaningful interventions should also involve EAC as a block. In addition, the Kenya government should also work to ensure tax laws are predictable and applied in a consistent manner to allow adequate operational and business planning for the private sector involved in off-grid refrigerators local assembly.

3. Introduce safeguarding tax to protect local industry

Local manufacturing of off-grid refrigerators is still at an early stage in Kenya and generally imported products mainly from China are significantly cheaper, frustrating progress towards localisation. The study recommends that at a point when domestic assemblers can suffice some local demand, duties and taxes can be introduced for imports to provide equal opportunities and protect the Kenyan manufacturing industry from cheap imported refrigerators. This should however be done smartly and cautiously accompanied by a quota system to ensure there is an appropriate mix of quantities of imports and domestic products to suffice demand.

India already has a safeguarding tax of ~15% on solar panels which can be extended to other components.

4. Provide capital subsidy and foreign investments to set-up local manufacturing / assembly facilities

For both India and Kenya, it will be crucial to provide capital subsidies to local manufacturers and assemblers so they can build up production facilities for off-grid solar refrigeration appliances and their essential parts, such as the DC compressors at the core of the solar refrigeration system. Moreover, the governments should collaborate with commercial banks to establish concessional financing products (preferably with less than 10% interest rate). Also for Kenya, as it builds its domestic ecosystem to enable localisation, the government should promote foreign investment in Kenya to facilitate the establishment of manufacturing and assembly facilities, similar to the Production Linked Incentive (PLI) scheme in India.

The government has extended fiscal incentives applicable to all manufacturers and assemblers in Special Economic Zones (SEZ) in Kenya which could be leveraged. For example, Kenya offers corporate tax holidays for manufacturers in Economic Processing Zones (EPZs), a 30% rebate to manufacturers. In addition, the Kenya Investment Authority (KenInvest) offers a one-stop shop for potential investors, facilitating registrations and setup and introductions to key stakeholders. To move a step ahead, the government of Kenya may consider setting up a dedicated economic zone for off-grid projects that would include refrigeration that could provide some incentives as follows:

- Subsidised energy and land costs
- In-house customs clearance facilities
- Exemption from duties on all imports for project development similar to arrangement implemented in the LAGAZEL's Benin Zawoue project
- Some % of FDI allowed through the automatic route for manufacturing activities
- Streamlined customs procedures and clearance

Moreover, local Kenyan companies interviewed for this study revealed that it is almost impossible to secure loans from local commercial banks to venture into local manufacturing of off-grid refrigerators as they cannot meet strict collateral requirements and high interest rates of about 12.1%. Under the circumstances, some manufacturers recommended that the Kenya government work with commercial banks to develop concessional financing products (ideally with less than 10% interest rate) to provide much needed working capital for local companies venturing into local assembly of off-grid refrigerators. The Youth Enterprise Development Fund under the Ministry of Public Service, Gender and Youth Affairs was cited as a good example of a government initiative to provide financial and business development support services to local enterprises. Thus, establishment of a similar fund that would focus on off-grid projects (including local manufacturing) will help to spur local manufacturing agenda for off-grid refrigerators.

Grants financing is also pivotal in boosting working capital to accelerate adoption of off-grid solar refrigeration technology which is still at its early stages.

5. Provide front-end subsidies for increasing the demand

Due to the high cost of off-grid solar refrigeration appliances, their rapid adoption requires solid financial backing. In India, OEMs can receive back-end subsidies for solar walk-in cold rooms, though its disbursement takes nearly two years which can discourage OEMs from adopting this support from the government.

This also further limits the demand which could have been otherwise met with front-end subsidies. Therefore, front-end subsidies are required to boost demand. While Kenyan government may not have the budget to support with massive subsidies, donor agencies and development banks need to work collaboratively to announce certain line of credits to give a boost to demand.

6. Provide funds for R&D activities and incubating technology start-ups

For a country to become a global leader and develop local supply chains, achieving technological excellence is key. In 2022, India's gross R&D expenditure was 0.65 percent of GDP, significantly lower than the top ten economies, which spend 1.5-3 percent of GDP on research and innovation. There is a need to invest in and incentivise R&D activities in order to become a technology leader and enable localisation. R&D in compressor technology will be critical to promoting the localisation of off-grid solar refrigeration appliances such as refrigerators and walk-in cold rooms. Similarly, in Kenya, more investment needs to be directed toward research and capacity building to improve local assembly's technical skills in terms of technology and the necessary materials to enable scale-up.

Thus, to support prototype testing, policy development, and creating awareness for the off-grid refrigeration industry more funding needs to be channelled to research and development activities with universities and other like-minded institutions. For example, the study found that financing is required to support data generation from R&D institutions to indicate adequate local technology and materials to be used for assembly of the cold chamber. As it stands cold chambers are predominantly assembled from imported components. Analysis of BoM for solar walk-in cold rooms for Kenya (see Figure 41) has revealed that the FOB imported cost of the complete built unit (CBU) cold room is higher than the cost of local assembly. This provides motivation for the local market to engage more in domestic assembling using imported components and it is envisaged manufacturing from local products will be far cheaper.

Local manufacturing of off-grid solar refrigerator appliances is still, in Kenya, funded by family resources or investors seeking humanitarian return - employment creation, building local technical skills base etc. Thus, financial and technical support is required to facilitate commercialisation and business expansion after proof of concept stage. To achieve this, the study recommends that the Kenya government in collaboration with developers should seek to support the development of state of the art, large scale incubation programs. The study established that D-Grid and Ecolife are at several stages of piloting pre-design and local assembly of containerised components of solar walk-in cold rooms for cooling fresh agricultural produce to test their models and understand the market. Such incubation programs will also help in analysis by dissemination of their findings to catalyse localisation.

Non-Fiscal measures for increased localisation

1. Create demand through public procurement, backed by minimum threshold quality parameters

With sales volume being the most important aspect of shifting toward localisation, demand for local off-grid solar refrigeration products and its components should be stimulated through interventions such as local content requirements in government procurement in India while through various funding agencies in Kenya. To encourage and support localisation, a portion of government procurement preference could also be given to enterprises that use high (more than 50%) local content in manufacturing. In India, the government could target sales in NITI Aayog aspirational districts (Adivasi area) where there is a high need for the appliances but no ability to pay. Furthermore, to ensure that this policy measure does not result in the development of substandard quality of off-grid solar refrigeration products or create inefficiencies in domestic enterprises, the preference in procurement can be made applicable with minimum quality standards.

Governments can be customers, for example by procuring solar walk-in cold room for rural areas which ultimately can be leased to end users through Cooling as a Service (CaaS) business model. In this case it is recommended that governments give preference to tenders for locally manufactured solar walk-in cold room. These procurements must ensure quality standards to avoid penetration of low-quality products in the markets.

Therefore, there is an opportunity for a huge demand for these components for other technologies, as well as off-grid solar refrigeration. For example, compressors are common components used in off-grid solar refrigeration and air-conditioners. India produces millions of AC compressors each year. Thus, volume is not a constraint for compressors, supporting a shift towards localisation. Technology awareness drives through county governments, extension officers, and other government infrastructure which can also be a lever of change that acts as a demand / pull driver or factor.

Consumer awareness campaigns can instill an awareness of the benefits and capabilities of locally manufactured off-grid solar refrigerators to accelerate their uptake.

2. Develop export-oriented markets

Domestic markets alone do not have enough demand. Marketing of off-grid solar refrigeration products would need to look beyond domestic markets to create an export hub. As a next step, Kenya could target the East Africa Community (EAC) region that constitutes of 8 partner states with 290 million population size as a region to export to. Kenyan assemblers could also potentially have preferential access to 21 African Member countries of the Common Market for Eastern and Southern Africa (COMESA) through trade agreements that Kenya is part of. India could also look for partnerships with these (African) countries and become export oriented.

3. Establish quality standards and test methods

In India, while Minimum Energy Performance Standards are available, conformity to these standards must be assessed. Government should work with agencies like VeraSol and IEC to establish quality standards and test methods for off-grid solar refrigeration appliances and ensure level playing field for manufacturers and distributors. Also, multiple testing labs will be required in both the countries, which are currently unavailable. As a result, OEMs ship their products to Europe for testing, which is both time consuming and costly.

4. Provide upskilling and capacity building for local assembly and manufacturing

A programme dedicated to upskilling gradation of the OSGR, and other solar-based appliance manufacturing workforce will be required, with a focus on both short-term actions to fill existing skill gaps and long-term initiatives to ensure projected skill requirements are developed in the ecosystem over time. In India, the National Skill Development Council (NSDC) or Power Sector Skill Council (PSSC) can support in developing vocational training programs for local assembly of different off-grid solar refrigeration appliance and its components. In Kenya, Indian universities (like IITs) can organise a knowledge sharing program and explore opportunities for collaboration in supporting training the graduates.

In Kenya, owing to a skills gap in the sector, there is a need to provide rigorous capacity building to assemble / manufacture complex off-grid solar refrigeration appliances and also to further operate them. This can be filled with industry-academia partnerships such as the one between Solar Cooling Engineering (SCE) a spinoff company of the Tropics / Subtropics group of the Institute of Agricultural Engineering of the University of Hohenheim in Germany and Strathmore University in Nairobi, which has enabled provision of Solar Powered Cooling & Refrigeration and hands-on training courses on solar powered cooling and refrigeration. SCE also provides technical support to local partner SunTransfer Kenya to pilot local assembly project for solar walk-in cold room.

Targeting a large pool of local technicians for conventional refrigerators, Kenya government in partnership with multi-year donor programs could sponsor local education or exchange programs to grow technical skills of local experts and eventually help them manufacture locally.

Thus, strong industry-academia relationships are needed to synergize R&D talent by establishing centres of excellence focused on developing off-grid solar refrigeration technologies and supporting the complex assembly / manufacturing of off-grid solar refrigeration appliances.

5. Explore partnership opportunities for south-south & triangular cooperation and leverage 'China-plus-one' strategy

There is a need to identify and encourage critical areas where South-South & triangular cooperation can be effective for OSGR industry growth. Some areas of interest could peer-to-peer learning of controller design and PCM technology for WICR. Furthermore, now is the time for India to leverage the 'China-plus-one' strategy, which can turn India into a manufacturing / assembly hub. In Kenya, there also lies a big opportunity area to explore south-south and triangular collaboration to facilitate technology development and transfer and creation of local value chains in Kenya. This can be done through a large number of knowledge and expertise exchanges from Asian counterparts (like India) in the areas of compressors, controllers, phase change materials, etc.

EXAMPLE: SOUTH-SOUTH CO-OPERATION AT THE CITY LEVEL IN INDIA, INDONESIA AND SOUTH AFRICA

BACKGROUND

Exponential population growth coupled with rapid economic development in many cities in the South necessitates smart solutions to ensure access to clean and affordable energy for all. Both Indonesia and South Africa are at a stage where national policies on climate change mitigation have been formulated; it is now time for cities to begin taking concrete action.

ICLEI

Local Governments for Sustainability (ICLEI), an international association of local governments committed to sustainable development, developed a local renewables initiative that steers city governments to integrate energy efficiency technologies and renewable energy generation into all city activities. The project cities of Ekurhuleni, South Africa, and Yogyakarta, Indonesia, joined the local renewables network to promote knowledge exchange between the cities and increase the uptake of renewable energy and energy efficiency technologies at the local level. The municipal authorities of Ekurhuleni and Yogyakarta were guided by the city of Coimbatore in India, an established local renewables city.

IMPACTS AND RESULTS

Upon completion of the three-year project:

- Impetus was provided for major cities in South Africa and Indonesia to work towards meeting national and international energy efficiency and emission reduction targets
- Long-term action plans were put in place following analysis of opportunities to reduce energy use and related carbon dioxide emissions
- Potential was identified for renewable energy and energy efficiency technologies to improve the delivery of municipal services
- Communities were catalysed to adopt renewable energy and energy efficiency initiatives at the household level thanks to resource centres showcasing case studies

Suggested actors to support implementation of the fiscal and non-fiscal measures

Table 10: Suggested actors to support implementation of the fiscal and non-fiscal measures

MEASURES	GOVERNMENT / POLICYMAKERS	OFF-GRID SOLAR REFRIGERATION INDUSTRY	DONOR AGENCIES / DEVELOPMENT BANKS
FISCAL MEASURES			
Reduce or exempt local taxes on appliance and its components	✓		
Upsurge import duties on import of completely built units	✓		
Introduce of Safeguarding tax in Kenya	✓		
Provide of capital subsidy and foreign investments to set-up local manufacturing / assembly facilities	✓		
Provide front-end subsidies for increasing the demand	✓		
Provide funds for R&D activities and incubating technology start-ups	✓	✓	✓
NON-FISCAL MEASURES			
Create demand through public procurement backed by minimum threshold quality parameters	✓		✓
Develop Export oriented market	✓		✓
Establish Quality Standards and Test Methods	✓		✓
Provide upskilling and capacity building for local assembly and local manufacturing	✓	✓	✓
Explore partnership opportunities for south-south & triangular cooperation and leverage 'China-plus-one' strategy	✓	✓	✓

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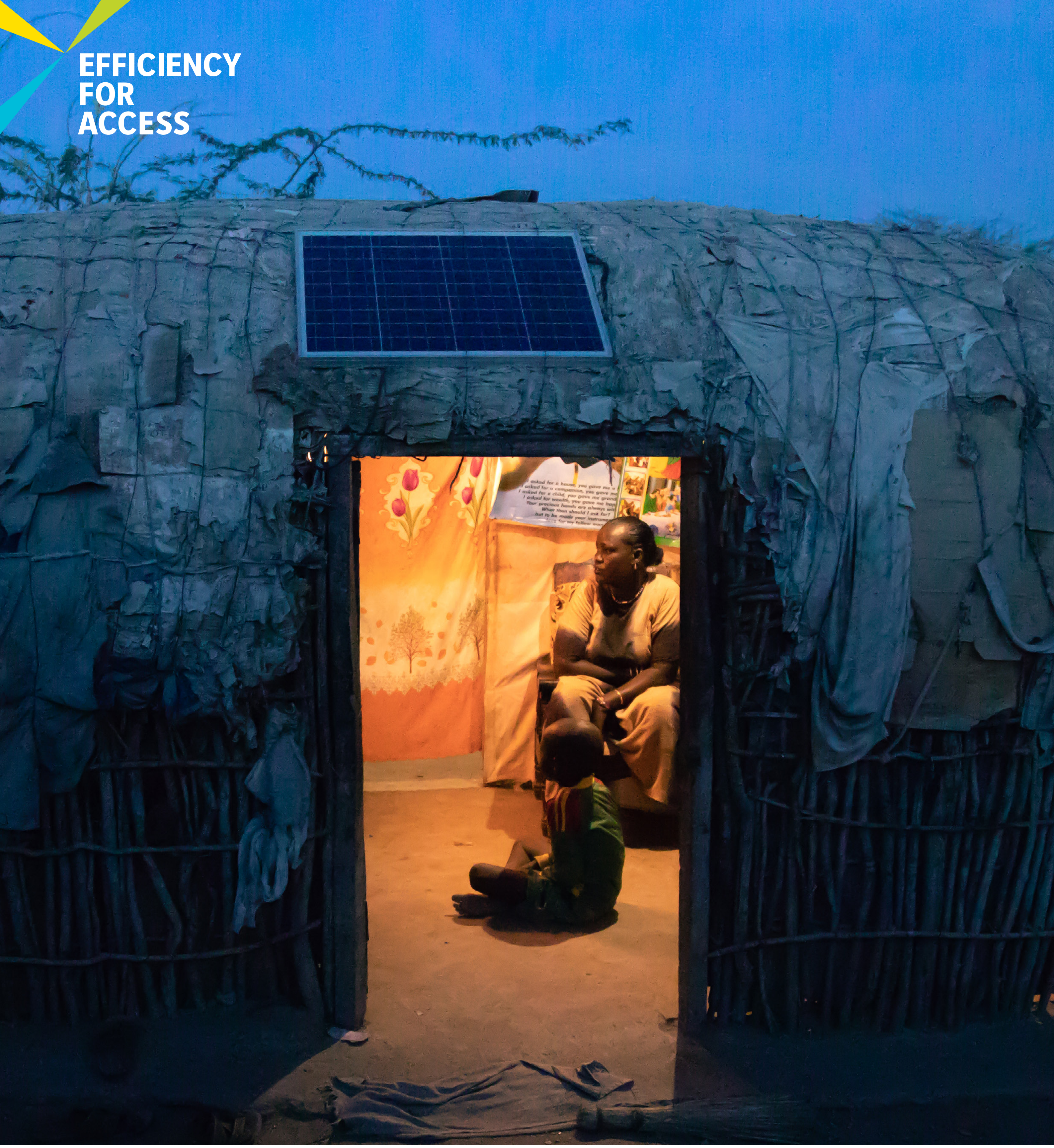

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